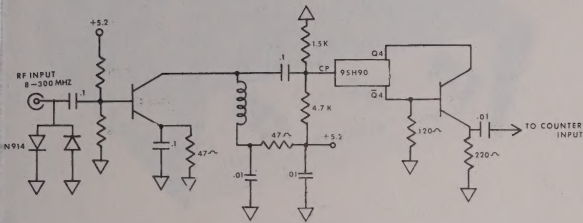


Berkley
7360 + 7350

Berkley 73604
7350

PD 301 PRESCALER



OPERATION:

Connect the output of the PD 301 with a short piece of RG 58U coax cable to the counter to be used. Connect antenna about 20" long (or other suitable pickup) to the input of the PD 301. Start with the antenna loosely coupled, increase coupling until the counter begins to count. We have found that the prescaler will pick up a signal from a 1 watt transmitter about ten feet away. Although the front end of the prescaler is protected with limiting diodes care should be taken to prevent overloading. Never hook the prescaler directly to the output of the transmitter.

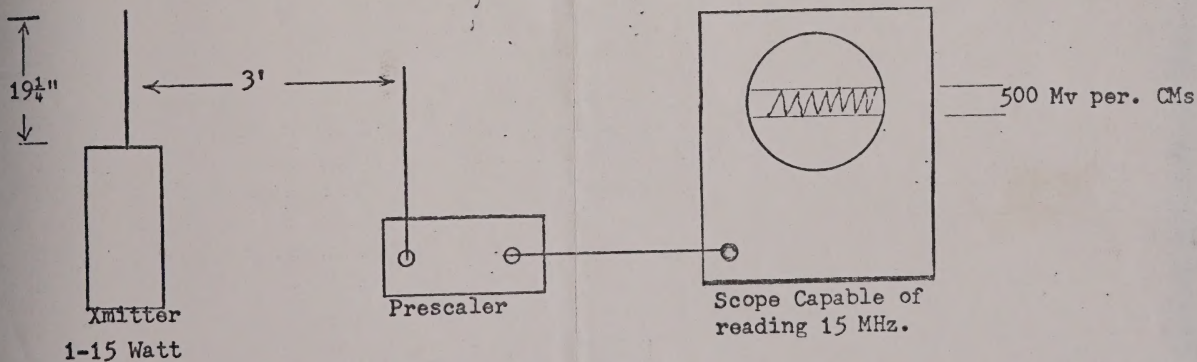
K-ENTERPRISES

1401 North Tucker

Shawnee, Oklahoma 74801

Using the PD 301 with a receiver you can do a reasonable job of adjusting frequency of a VHF transmitter by scaling down to low band receiver. If you want to zero in on 146.940 just tune your receiver to 14.694 and you're ready to go.

QUICK CHECK FOR THE P.D. 301 PRESCALER



A quick check for the PD-301 is shown above using a small transmitter from 1 to 15 watts set up as shown above the output of the prescaler will read from 400 Mvs to 700 Mvs. This is enough signal for any counter that is in good working order. Keep in mind that many frequency generators do not deliver more than about 10 Mv. Counters lose their sensitivity as they age. If the prescaler is delivering 400 Mv output and the counter fails to count it indicates that the front end of your counter needs peaking up.

K-ENTERPRISES

Manual for 7350 Universal Eput and Timer
&
Accessories

Manual Divisions:

I Manual for 7350 and 7360 Counters

II Manual for Decimal Counting Units

III Manual for P.D. 301 Prescaler

INSTRUCTION MANUAL

MO-310 & 7350
Section I
UNIVERSAL STOP AND TIMER

UNIVERSAL STOP AND TIMER

UNIVERSAL STOP AND TIMER

3-4100-1

Berkeley

BERKELEY INSTRUMENTS, INC.
1000 UNIVERSITY AVENUE, SUITE 100
BERKELEY, CALIF. 94702

H.E. Edison / 5

INSTRUCTION MANUAL

MODELS 7360 & 7350
UNIVERSAL EPUT[®] AND TIMER

INDUSTRIAL AND NUCLEAR INSTRUMENTS

ANALOG COMPUTERS

(3-110) (1)-1

Berkeley *division*

BECKMAN INSTRUMENTS, INC.
2200 WRIGHT AVE., RICHMOND, CALIF.
TELEPHONE: LANDSCAPE 6-7730

*2nd
edn
4/1/60
1/1/60
1/1/60
1/1/60
1/1/60*

1 Introduction

DESCRIPTION

The Universal EPUT* and Timer, Models 7360 and 7350, is an electronic counter which will perform a wide variety of frequency and time measurements. These various functions are described below under "SPECIFICATIONS". The instrument consists of a precision clock-pulse generator, two input pulse-forming (trigger) channels, an electronic gate and a chain of decimal counting units (DCU's). When measuring frequency, each input signal cycle triggers a sharp voltage pulse on one of the input channels. These pulses pass through the gate and are counted by the DCU's during a precise time interval established by the clock-pulse generator.

When measuring time, clock pulses are let through the gate and counted during a interval controlled by input signals.

The Model 7360 differs from the Model 7350 primarily in the highest frequency which may be measured and in the smallest unit of time measurement available. The Model 7360 will measure frequencies as high as 1MC, whereas the Model 7350 is limited to 100KC. The Model 7360 will make time measurements in one- μ second units while the smallest unit of time measurement on the Model 7350 is 10 μ seconds.

SPECIFICATIONS

FUNCTIONS

1. Measures frequency or counts events-per-unit-time over a maximum automatic time interval of 10 seconds with a manual extension beyond 10 seconds for extreme accuracy.
2. Measures period of a wave or the width of a pulse. Measures ten periods when greater accuracy is desired.
3. Measures the time interval between two events represented by pulses on separate input channels. When a signal is applied to one channel and the same signal in a different phase to the other channel, the result of this measurement is the phase difference.

4. Counts the number of events occurring between two events represented on the same input channel. If the events to be counted are cycles of a signal of one frequency and the two events which begin and end the counting period are successive cycles of a lower frequency, the result of this measurement is the ratio of the frequencies.
5. Counts events over a manually controlled time interval.
6. Makes self-check on accuracy of clock signals and Decimal Counting Units.
7. Performs any of the above functions with an external frequency substituted for the internal oscillator frequency.

PERFORMANCE CHARACTERISTICS

Input Trigger Channels

Input frequency range
d-c to 1MC

Input impedance

10 megohms in parallel with 40 μ f

Input sensitivity

100 millivolts rms, 0.3 volts peak-
to peak from d-c to 1MC

Input voltage attenuation

1, 10 or 100 a-c and d-c

Overload limits

Input impedance drops below
10 megohms when input voltage
rises above +1 volts d-c after
attenuation.

Trigger voltage level

Adjustable from -1 to +1 volts
at the attenuated signal

Trigger slope

Plus or minus

Clock-pulse Generator

Output frequency

Selectable in decade steps from 1 cps
to 1MC on the Model 7360 and from 1
cps to 100KC on the Model 7350

Output signal

0.25 μ seconds pulse 5 volts high out
of 500ohms, available for external
use.

Oscillator Stability

Model 7360: 2 parts in 10^7 per week

Model 7350: 1 part in 10^6 per day

Gate, Control Circuits and DCU's

Resolution

Model 7360: 0.8 μ seconds

Model 7350: 5 μ seconds

Capacity

Model 7360: 10^7 counts

Model 7350: 10^6 counts

Display

Continuously variable from .05
to 5 seconds.

4-line code from DCU's to external
connector

APPLICATIONS

The Universal Eput and Timer can be used to make a wide variety of frequency and time measurements both in the laboratory and on the production line. It is useful in designing transmitters, receivers, tuned circuits, crystals, oscillators and other equipment which must have definite frequency characteristics. On the production line the instrument is ideal for making stability checks on transmitting and receiving equipment and on crystals during heat cycling. It may also be used to calibrate less accurate frequency monitoring equipment.

Various transducers such as photocells, magnetic pickups and switches may be used to produce voltage changes representing physical events. So equipped, the instrument will measure the char-

acteristics of such events relative to time. Some of the known applications of the instrument are:

* Frequency measurements

Frequency ratio measurements

Relay and switch timing

Phase measurements

Viscosity and ballistic measurements

Elasticity measurements

Tachometry

Telemetry

Pulse height analysis

* Oscilloscope time base calibration

* Use as a secondary frequency standard

The versatility of the instrument can be fully utilized only when it is equipped with the proper accessories. Numerous transducers such as the Model 442 Reflecting Tachometer as well as sev-

ral data recording and data reduction instruments are available at Berkeley. The Model 1452 Digital Recorder, designed for use with this instrument, converts count information into a printed record. The unit prints the count accumulated by the counter during each counting period. The printed count appears sequentially in Arabic numerals on a standard adding machine tape. This recorder is ideal for making long term stability checks, recording transients, monitoring, or for making a permanent printed record in control or measuring systems.

The Model 1440 Series, Data Reduction Converters, convert digital information from the counter to a form suitable for actuating an IBM summary punch or an electric typewriter. These converters have uses similar to those of the Digital Recorder. The Model 1440S is designed for use with the IBM Summary Punch Type 523; the Model 1441S, for use with the IBM Summary Punch Type 615, and the Model 1442S, for use with an electric typewriter. On special order Berkeley

will prepare a modification of the Model 1442S, which will drive a teletype or a microwave link. In this way count information may be made instantaneously available at various remote locations.

The Model 1445 Digital to Analog Converter converts the count accumulated during each counting period to a representative voltage level. This voltage is held until a new count is completed when it changes to conform with the new count. The unit may be used with a self-balancing potentiometer to provide an analog record, or the changing voltage level may be used to control the operation being monitored.

With the exception of the modified Model 1442S, the instruments described above are standard accessories. Other converters, transducers and special equipment may be ordered to meet specific problems.

2 Operation

OVER-ALL DESIGN

The counter will make three types of measurements aside from simple counting.

1. It will count the number of events occurring during a precise time interval. This is known as Events-Per-Unit Time or E/UT Operation. Frequency measurements are made in this way. The SCAN function is a variation of this operation.
2. It will measure the time interval between two events. If the two events are represented by voltage changes on separate input channels, it is called Time-Interval-Measurement or TIM Operation. If the two events are represented on the same input channel this is known as PERIOD Operation.
3. It will count the number of events occurring between two other events. This is Ratio or A/B Operation.

If the events mentioned above are not initially voltage changes, appropriate transducers are used to produce voltage changes representing the events at the counter INPUTS. Two input trigger channels within the counter convert the voltage changes they receive into sharp pulses. A clock-pulse generator in the instrument produces similar pulses separated by a precise time interval. Besides these three pulse sources the counter contains an electronic gate and a chain of decimal counting units. (DCU's). The DCU's count and indicate the number of pulses which pass through the gate between a start pulse which opens it and a stop pulse which closes it.

The FUNCTION switch determines the type of

measurement made by selecting the pulse source which provides each of the three signals -- pulses to be counted, the start pulse and the stop pulse.

1. Under E/UT Operation one of the input channels provides pulses which are counted over the known time interval between start and stop pulses from clock-pulse generator. With the proper placement of a decimal point the lighted DCU's indicate events or cycles per second.
2. Under PERIOD or TIM Operation pulses of known frequency from the clock-pulse generator are counted over an unknown interval between start and stop pulses from one or both of the input channels. Since the clock-pulse frequency is equal to the LMC or 100KC oscillator frequency divided by a power of 10, the time measurement appears directly in decimal fractions of a second.
3. Under A/B Operation pulses from one of the input channels are counted between start and stop pulses from the other channel. If the events represented by the pulses are cycles of input signal waves, the DCU's indicate the number of cycles at one input which occur during one cycle at the other INPUT or, in other words, a frequency ratio.

During all "times ten" (x 10) operations the start-stop pulse frequency is divided by 10 so that the counting period is multiplied by 10 and the reading is 10 times as large. Figures 4a thru f show the selection of pulse sources for each operation.

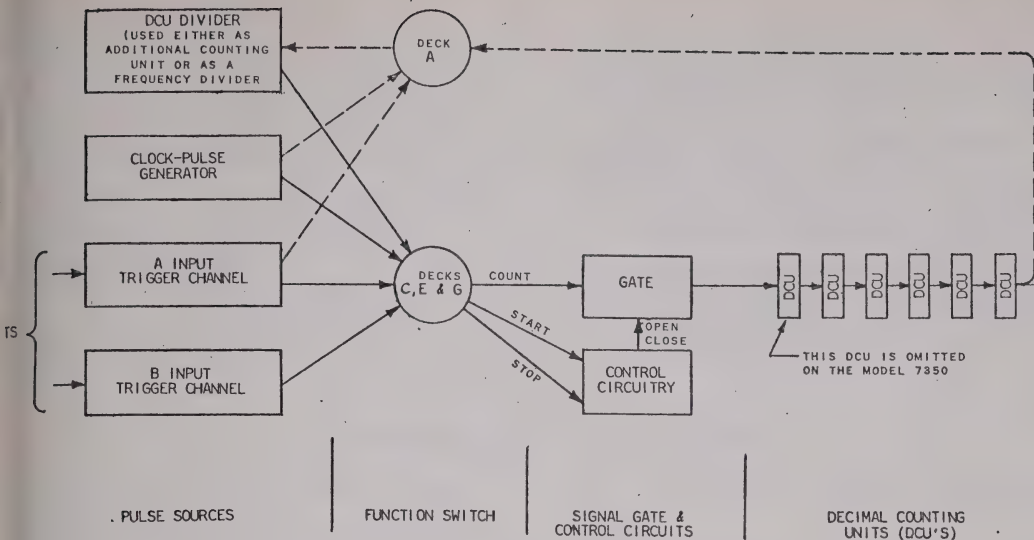


Figure 2 Signal Paths between Major Components

OPERATING CONTROL & CONNECTOR FUNCTIONS

CONTROLS

POWER switch

Turns power on and off.

FUNCTION switch

1. Interconnects major components to perform the measurement indicated by the pointer.
2. Used to manually control COUNT and SCAN operations.

TIME-SECONDS switch

Selects time interval for events-per-unit-time & TEST measurements and unit of time measurement for PERIOD and TIM measurements.

ATTENUATION controls

Attenuates the signal at the adjacent INPUT jack by the voltage factor to which the pointer is set. When turned

to the AC side only the a-c component of the input signal reaches the input trigger channel.

TRIGGER VOLTAGE Controls

Selects the instantaneous voltage at which the attenuated signal triggers the adjacent input channel.

SLOPE switches

Selects the slope of the input voltage waveform which triggers the input channel pulse used to operate the gate and control circuitry. The input channel which each SLOPE Switch affects varies with the position of the FUNCTION switch. See "PERFORMING SPECIFIC OPERATIONS" to determine the function of the SLOPE switches at a particular position of the FUNCTION switch.

DISPLAY Time Control

Determines how long the instrument holds a reading before resetting and beginning another count. When this control is turned to the extreme clockwise position, the instrument will hold a reading until the manual RESET button is depressed.

Manual RESET button

Removes the previous reading and readies the instrument to begin another counting period.

CONNECTORS

INPUT Trigger Channel jacks (B-START-E/UT PERIOD and A-STOP)

Inputs to the two Trigger Channels.

FREQUENCY Jack (Chassis Rear)

When the EXT-INT switch is at INTERNAL the oscillator signal is available here.

When the switch is at EXTERNAL, the external reference frequency must be connected to this jack.

COUNTER INPUT ADJUSTMENTS

The ATTENUATION controls operate upon the signal introduced at the adjacent INPUT jack before it reaches that Input Trigger Channel. The input voltage is divided by the factor indicated by the pointer. When the pointer is on the side labelled "DC", the total input signal is attenuated and passed on to the input channel. When the pointer is on the side labelled "AC", the d-c component is removed and only the a-c component of the input signal is attenuated and passed on the "AC" position.

The input channel following the attenuator produces a sharp pulse each time the instantaneous voltage of the attenuated signal passes through a certain voltage level. This level is selected by the TRIGGER VOLTAGE control. It may be varied continuously from -1 to +1 volts. A pulse is produced when the attenuated voltage crosses the triggering level going in a positive direction and another when it crosses going negative. Pulses triggered by positive-going voltage excursions are said to be triggered on the positive slope; pulses triggered by negative-going voltages, on the negative slope. The SLOPE switches determine whether those triggered on positive or negative slopes shall be used to operate the succeeding circuitry. THE SLOPE SWITCHES ARE NOT ALWAYS ASSOCIATED WITH THE ADJACENT INPUT CHANNEL. See "PERFORMING SPECIFIC OPERATIONS" to learn how

they operate at each position of the FUNCTION Switch.

The input impedance at the jack is 10 megohms in parallel with 40 μ f. This impedance may be reduced to match the source or to avoid capacitive pickup by attaching a "T" connector to the jack and adding resistors or capacitors in parallel. Do not introduce an input signal stronger than 500 volts peak-to-ground. The input sensitivity is equal to 0.3 volts peak-to-peak times the factor to which the attenuation control is set.

The purpose of the Input Trigger Channel is to produce a reliable pulse output representing that part of the input signal in which the operator is interested. This is achieved only when the ATTENUATION and TRIGGER VOLTAGE controls are properly adjusted. Before attempting to adjust the controls it is best to visualize the shape, amplitude and distance from ground of the input signal. The effect of various control settings is then relatively easy to calculate. Refer to Figure 3 which illustrates the effect of the controls on a simple waveform. The "+" trigger voltage and the "-" trigger voltage, separated by about 0.3 volts, may be set anywhere from about -1 to +1 volts. The attenuated signal voltage must pass through both "-" and "+" levels to trigger pulses. To avoid overdriving the channel the attenuated signal should never rise above +10 volts. If the attenuated signal voltage rises

+1 volts the input impedance drops below
gohms. At +10 volts the input impedance
negohm.

e that:

1. If the attenuated signal is small the trigger voltage may be set so high or so low that no pulses are produced.
2. If the attenuated voltage variations ride on a d-c level they may not come within the trigger voltage range.
3. Any attenuated voltage variation less than 0.3 volts peak-to-peak will not trigger pulses.
4. Modulation or variations in the d-c level of the attenuated signal are least likely to subtract pulses if the trigger voltage

is set about halfway between the peaks of the signal.

5. Extraneous noise has the least effect on the time at which a pulse occurs when the channel triggers on a steep slope of the waveform.
6. Attenuating the input signal
 - (a) Reduces the slope at all points.
 - (b) Shifts the a-c component nearer ground if it rides on a d-c level.
 - (c) Increases the minimum peak-to-peak variations necessary to trigger pulses from 0.3 volts to 3 or 30 volts.
 - (d) Increases the range of possible trigger voltage settings on the input signal from 2 volts to 20 or 200 volts.

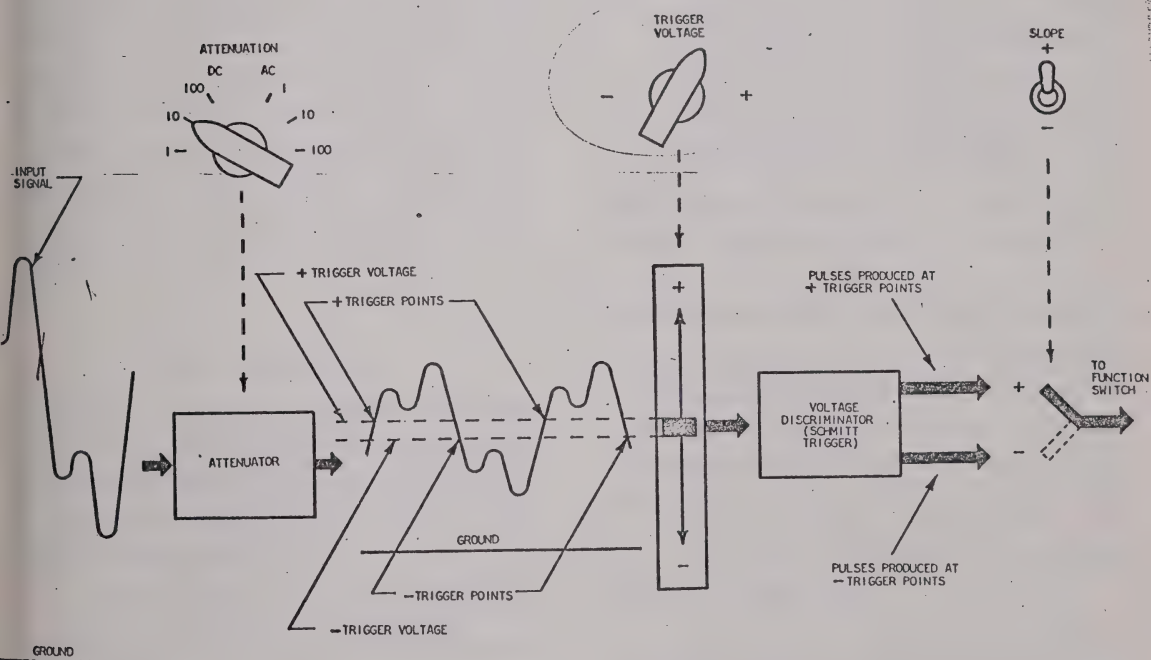


Figure 3. Effect of Input Controls

Adjustment of the ATTENUATION and TRIGGER VOLTAGE controls should be made keeping the above characteristics in mind. When using any regular periodic input signal, consistent E/UT or PERIOD readings are a good indication that the controls are properly adjusted.

The trigger voltage may be set at a precise value by applying a d-c voltage of that value at the INPUT jack, setting the ATTENUATION control at an appropriate factor on the DC side and rotating the TRIGGER VOLTAGE control to the point where an output pulse is produced. With no input voltage the INPUT jack lies at ground and a

pulse will be produced at ground level. Output pulses from the B channel may be seen being counted when the FUNCTION switch is at E/UT. Pulses from the A channel are counted on the A/B position.

Some information about the position of the trigger voltage relative to the signal may be extracted from the instrument itself. The trigger voltage may be varied between the positive and negative peaks of an attenuated signal whose peaks lie within the range -1 to +1 volts. As the trigger voltage passes beyond the signal peaks the pulse output of the channel will cease and these positions of the control may be noted.

PERFORMING SPECIFIC OPERATIONS

MEASURING FREQUENCY

The frequency of a regular sine-wave signal can be measured either directly under E/UT or E/UT x 10 Operation or indirectly by measuring the period of the signal and calculating the frequency. The direct method is simpler and will ordinarily be used except when measuring a low frequency signal with extreme accuracy. See the "ACCURACY" section of this manual for the accuracy limitations of events-per-unit-time operation.

TEST Operation

To put the instrument in operation connect the power cord and place the POWER switch in the position which lights the green indicator above it. After a two minute warm-up, test the instrument for proper operation:

1. Turn DISPLAY Time to a point near the extreme counter -clockwise position to obtain a short display time and automatic operation.
2. Turn FUNCTION switch to TEST.
3. Rotate TIME switch to each position starting with the 10-5 seconds setting on the

Model 7360 or the 10^{-4} seconds setting on the Model 7350. In either case this should give a reading of 10. As the switch is turned clockwise, other settings should read successively 100, 1000 or 999, 10, 000 or 9, 999, 100, 000 or 99, 999 and (on the Model 7360 only) 1, 000, 000 or 999, 999

Note that the DISPLAY time is infinite at the extreme clockwise position of the control. In this position, the instrument must be reset manually.

E/UT (Events-Per-Unit-Time) Operation

At the E/UT position of the FUNCTION switch the unit counts the input to the B Channel between start and stop signals separated by a precise time interval. This setting may be used to measure the frequency of a signal or the number of events occurring within a selected time interval. The major components are connected as diagramed in Figure 4a.

To make a measurement proceed as follows:

1. Connect input to B channel. (See "COUNT-ER INPUT ADJUSTMENTS" above.)
2. Rotate the FUNCTION switch to the E/UT position. In this position the SLOPE

A/B Operation

At the A/B position of the FUNCTION switch the unit counts the signal at the A INPUT between consecutive voltage excursions through a selected level at the B INPUT. This setting may be used to measure the ratio of two frequencies or to count the number of events occurring while the A INPUT is above or below a given voltage level. The major components are connected as diagrammed in Figure 4b.

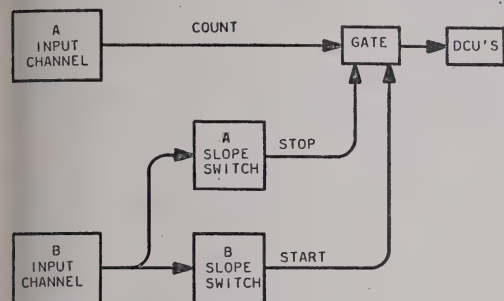


Figure 4b

To make a measurement proceed as follows:

1. Connect the higher frequency to the A INPUT jack and the lower frequency to the B INPUT jack. (See "COUNTER INPUT ADJUSTMENTS" above.)
2. Rotate the FUNCTION switch to A/B. In this position the SLOPE switch on the B side of the panel determines the polarity of the voltage excursion which begins count of the A input. The other SLOPE switch sets the polarity of that which ends the counting period.
3. Therefore,
 - (a) When measuring the ratio of two frequencies set both SLOPE switches "+" or both to "-".
 - (b) When counting the A input during the period the B input voltage remains above a certain level, set the SLOPE switch on the B side to "+" and the other to "-".
 - (c) When counting the A input during the

period the B input voltage remains below a certain level, set the SLOPE switch on the B side to "-" and the other to "+".

4. Adjust the DISPLAY TIME control to a position at which the count on the lighted DCU's may be read conveniently.
5. Take a reading. When measuring a frequency ratio the DCU's indicate the ratio of the A input frequency to the B input frequency.

A/B x 10 Operation

At the A/B x 10 position of the FUNCTION switch the unit counts the signal at the A INPUT between a voltage excursion through a selected level at the B INPUT and the tenth following excursion. This setting will measure a frequency ratio more accurately than the A/B operation. The major components are connected as diagrammed in Figure 4c.

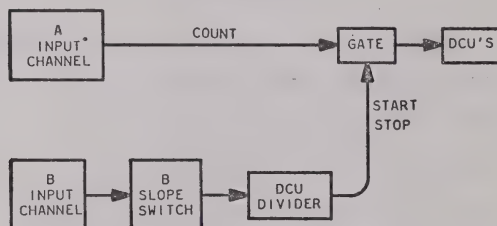


Figure 4c

To make a measurement proceed as follows:

1. Connect the higher frequency to the A INPUT jack and the lower frequency to the B INPUT jack. (See "COUNTER INPUT ADJUSTMENT" above.)
2. Rotate the FUNCTION switch to A/B x 10. In this position the B SLOPE switch determines the polarity of the voltage excursion which begins and ends counting.
3. For greatest accuracy set this SLOPE switch on the steeper slope of the B input.
4. Adjust the DISPLAY TIME control to a position at which the count on the lighted DCU's may be read conveniently.

5. Divide the reading by 10 to obtain the ratio of the A INPUT frequency to the B INPUT frequency.

TIM (Time-Interval-Meter) Operation

At TIM position of the FUNCTION switch the unit measures the time between a voltage excursion through a selected level at the B (START) INPUT and a voltage excursion through an independently chosen level at the A (STOP) INPUT. The major components are connected as diagrammed in Figure 4d.

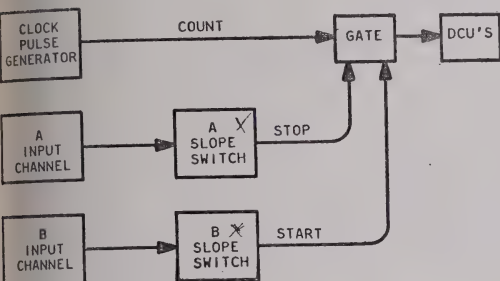


Figure 4d

To make a measurement proceed as follows:

1. Connect the start signal to the START INPUT and the stop signal to the STOP INPUT. (See "COUNTER INPUT ADJUSTMENTS" above.)
2. Rotate the FUNCTION switch to TIM. In this position the B SLOPE selects the polarity of the voltage excursion which begins the timing period. The A SLOPE switch selects the polarity of that which ends the timing period.
3. Rotate the TIME switch to the desired unit of time measurement. For example, at the 10^{-4} position the time measurement appears in ten-thousandths of a second. The smaller the time unit chosen, the more accurate the reading.
4. Adjust the DISPLAY time control to a position at which the count on the lighted DCU's may be read conveniently.

5. To obtain a reading in seconds, multiply the count on the DCU's by the factor to which the TIME switch is set.

PERIOD Operation

At the PER position of the FUNCTION switch the unit measures the time interval between consecutive voltage excursions through a selected level at the B INPUT. This setting may be used to measure the period of a wave or the width of a pulse. The major components are connected as in Figure 4e.

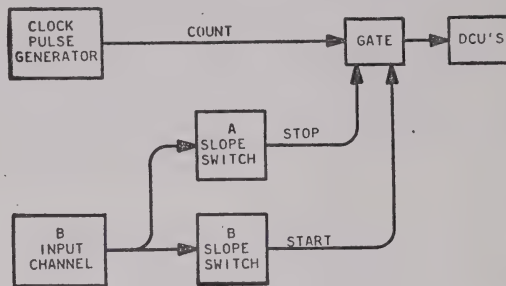


Figure 4e

To make a measurement proceed as follows:

1. Connect the wave or pulse source to the B (PERIOD) INPUT. (See "COUNTER INPUT ADJUSTMENTS" above.)
2. Rotate the FUNCTION switch to PERIOD. At this position the B SLOPE switch selects the polarity of the voltage excursion which begins the timing period. The A SLOPE switch selects the polarity of that which ends the timing period.
3. Therefore,
 - (a) When measuring the period of a wave, set both SLOPE switches to "+" or both to "-".
 - (b) When measuring the width of a positive pulse, set the B SLOPE switch to "+" and the A SLOPE switch to "-".
 - (c) When measuring a negative pulse, set the B SLOPE switch to "-" and the A SLOPE switch to "+",
4. Follow steps 3, 4 & 5 under "TIM Operation".

PERIOD x 10 Operation

The unit measures the time interval between a voltage excursion through a selected level at the B INPUT and the tenth following excursion. This setting will measure the period of a wave more accurately than the PERIOD operation. The major components are connected as diagramed in Figure 4f.

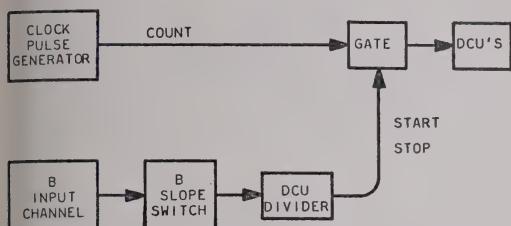


Figure 4f

To make a measurement proceed as follows:

1. Connect the wave source to the B (PERIOD) INPUT. (See "COUNTER INPUT ADJUSTMENTS" above.)
2. Rotate the FUNCTION switch to PERIOD x 10. The B SLOPE switch selects the polarity of both start and stop voltage excursions.
- 3., 4 & 5. Follow steps 3, 4 & 5 under "TIM Operation".
6. Divide the reading by 10 to obtain the length of one period.

COUNT Operation

The unit counts the input to the B channel during the period the FUNCTION switch is in the COUNT Position.

1. Connect input to B channel. (See "COUNTER INPUT ADJUSTMENTS" above.)
2. Turn FUNCTION switch to OFF.
3. Depress manual RESET button.
4. Twist FUNCTION switch to COUNT to begin counting.
5. Twist FUNCTION switch to OFF to stop counting.

GATE Operation

This operation is a variation of TIM operation. Pulses generated by an external signal are substituted for internal clock pulses. The instrument counts cycles of the substituted signal between a voltage excursion through a selected level as the B (START) INPUT and a voltage excursion through an independently chosen level at the A (STOP) INPUT.

The substituted signal must have an amplitude of 3 volts rms into a 7K load. Its frequency may be as high as 100KC in the case of the Model 7350 or as high as 1MC in the case of the Model 7360. Couple the signal to the FREQ. jack at the rear of the counter and place the EXT-INT switch at EXT.

NOTE: The .01 μ f capacitor (C401) connected between the FREQ. jack and the input circuit used for this operation is not large enough to pass frequencies lower than 10KC. If the external signal frequency is lower than 10KC, jumper this capacitor and connect a larger capacitor between the signal source and the FREQ. jack.

Rotate the TIME switch to 10^{-5} on the Model 7350 or to 10^{-6} on the Model 7360. Place the FUNCTION switch at TIM. Adjust the START and STOP input channels as described under "INPUT ADJUSTMENTS". See "TIM Operation" to learn how the SLOPE switches operate on these channels. The shaper stage of the clock pulse generator is used as the input trigger channel for the signal introduced at the FREQ. jack. Adjust the input trigger voltage of this channel with the SHAPER LEVEL control located on the top side of the counter chassis. Rotate this control to find the limits of the range in which the instrument counts. Set the control at the center of this range.

USING AN EXTERNAL

REFERENCE FREQUENCY

external reference frequency may be substituted for the internal oscillator signal. Introduce the external signal as described under "ATE Operation," but place the TIME switch at position which produces a clock pulse frequency equal to the reference frequency divided by the desired power of 10.

REMOTE CONTROL OF OPERATING CYCLE

The counter can be controlled from a remote location so that it will not reset and begin another

count until desired. Set the DISPLAY time control at a minimum and string a lead from the remote location to Pin 40 of the DIGITAL RECORDER socket. As long as this lead is grounded the counter will not reset. If a count is complete, then within 40 milliseconds after the lead is ungrounded the counter will have reset and be ready to start counting when a start pulse appears. As soon as the counter has reset, the lead may be grounded again or left ungrounded. It will not affect the operating cycle until the time arrives for the next automatic reset. At that time it must be grounded again to prevent reset.

ACCURACY

Measurements are subject to four important sources of error.

1. Counts missed or added as the Gate opens and closes.
2. Clock signal inaccuracy.
3. Errors in the time a start or stop pulse is triggered.
4. Counts missed because they occur during the resolution time of the counting circuits.

pulses which occur simultaneously with the opening or closing of the Gate may or may not be counted. This causes all measurements to vary plus or minus one count. The following equation defines the possible error introduced.

$$(1) \text{ Max. \% error} = \frac{1}{\text{Count Indication}} \times 100.$$

Notice that measurements set up to yield the highest count indication will be most accurate.

The frequency of a sine wave signal can be measured directly by counting events-per-unit-time or indirectly by measuring the length of one period and calculating the frequency. Higher frequencies yield the highest count indication when measured directly, that is, using the E/UT or E/UT x 10 function. Lower frequencies produce the highest indication when rapid time signals are

counted over one or ten periods - that is, using the PERIOD or PERIOD x 10 function.

On the Model 7360 frequencies above 1KC produce the highest count indication when measured using the E/UT x 10 function and a 10-second time interval; frequencies below 1KC yield the highest count when measured with the PERIOD x 10 function and a 1 μsecond unit of time measurement. The accuracy achieved using alternative functions at various frequencies is graphically illustrated in Figure 6. Note that the curves for E/PUT x 10 (10-second interval) and PERIOD x 10 (1 μsec time unit) cross at 1KC. This frequency cannot be measured with a possible error less than .01%. Frequencies above and below may be measured with greater accuracy.

The smallest unit of time available on the Model 7350 is 10 μseconds. Lower frequencies are most accurately measured using the PERIOD x 10 function and this time unit. Notice on Figure 5 that this curve crosses the EPUT x 10 curve at 316 cps. Therefore on the Model 7350 frequencies above 316 cps are most accurately measured using EPUT x 10 and a 10-second time interval whereas frequencies below 316 cps are best measured using the PERIOD x 10 function and the 10 μsecond unit of time. 316 cps cannot be measured with a possible error less than .03%,

7350 $\rightarrow$.0001 error per day.

lower and higher frequencies may be measured more accurately.

All measurements requiring a time signal (i.e. all measurements except A/B, A/B x 10 and COUNT) are subject to an additional error introduced by variations in the oscillator frequency. The oscillator frequency in the Model 7360 is stable to 2 parts in 10^7 per week, so it can cause a maximum error of only .00002%. The oscillator in the Model 7350 is stable to 1 part in 10^6 per day. It causes a maximum error of .0001%.

Measurements using an external signal to trigger start and stop pulses (i.e. PERIOD, PERIOD x 10, TIM, A/B and A/B x 10) may be subject to a further error caused by pulses which are triggered too soon or too late. Refer to Figure 5 which illustrates what occurs during a simple period measurement.

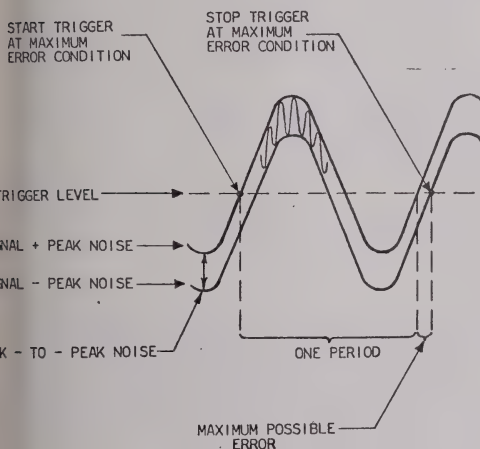


Figure 5 Effect of Noise on Accuracy of Period Measurements

Consider the total signal as an ideal signal intended to trigger the input channel plus a noise signal. The noise voltages added or subtracted from the ideal signal may trigger a pulse before or after the instant at

which counting should begin or end. The maximum error in the time of triggering will be proportional to the noise amplitude and inversely proportional to the slope of the ideal signal at the trigger level. Expressed mathematically,

$$(2) t \text{ (secs)} = \frac{V_n \text{ (volts)}}{S \text{ (volts/sec)}}$$

where t = Max. error in trigger time

V_n = peak-to-peak noise

S = slope of ideal signal at trigger level

The total noise (V_n) is equal to that carried by the input signal after attenuation plus that internally generated by the input channel. The internal noise (which takes the form of amplifier drift, trigger level jitter, line frequency pick-up, etc) is not more than 300 microvolts. Note that as the amplitude of the input signal is increased, S in equation (2) becomes larger and the internal noise causes less error.

The percentage error may be calculated by dividing the error in trigger time by the counting period and multiplying by 100. In the common case of a period measurement of a sine wave triggering at its zero cross-over value:

$$(3) \text{ Max. \% error} = \frac{V_n \text{ (volts)}}{V_s \text{ (volts)} \times \pi} \times 100$$

where V_n = peak-to-peak noise

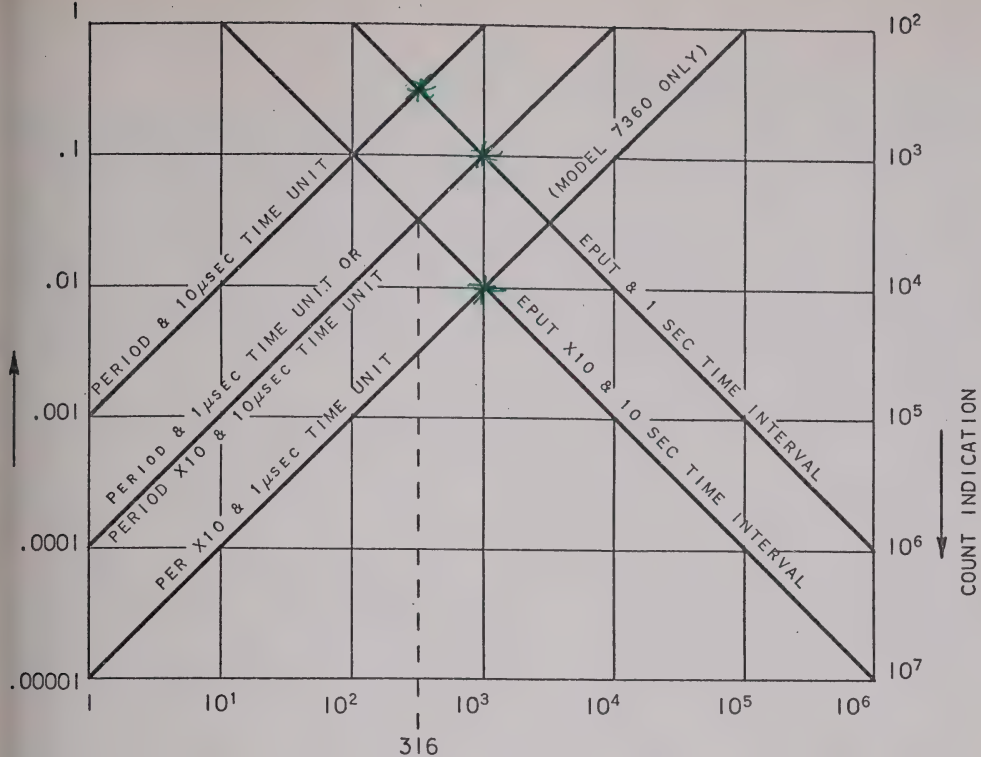
V_s = peak-to-peak signal

The maximum percent error of a PERIOD x 10 measurement is one-tenth the value given in equation (3).

The total error due to the three causes mentioned above is equal to the sum of the separate errors.

Total Max. percent error equals:

$\frac{100}{\text{Count Indication}}$	$+ \begin{matrix} .00002 \text{ (7360)} \\ \text{or} \\ .0001 \text{ (7350)} \end{matrix}$	$+ \text{Percent error due to noise}$
$\downarrow$	$\downarrow$	$\downarrow$
$\begin{matrix} \text{If } E/UT \\ E/UT \times 10 \\ \text{PERIOD} \\ \text{PERIOD} \times 10 \end{matrix}$	$\begin{matrix} \text{If PERIOD} \\ \text{PERIOD} \times 10 \\ \text{TIM, A/B} \\ \text{or A/B} \times 10 \end{matrix}$	



MEASURED FREQUENCY IN CPS

NOTE: THE 1μSECOND TIME UNIT IS NOT AVAILABLE ON THE MODEL 7350

Figure 6 Error due to ± 1 Count Limitation

Another source of error becomes important when random events are counted. One such event may occur immediately after another, before the counting circuits are fully recovered and prepared to register it. The second event will not only fail to cause a count but its effect on the circuitry may cause a third event to fail to register also. Formulae for calculating the counting error

due to this effect may be found in "Application of Probability Theory to Nuclear Particle Detection", L. J. Rainwater and C. S. Wu, Nucleonics, October 1947. The minimum time which must elapse between events if both are to be counted is called resolution time of the instrument. The Model 7360 has a resolution time of .8 μseconds. The Model 7350 has a resolution time of 5 μseconds.

AUXILIARY CONNECTORS

DIGITAL RECORDER Jack. Each DCU generates a 4-line code representing the digit it is displaying. These lines are collected at the DIGITAL RECORDER socket at the rear of the instrument. The Model 1452 Digital Recorder plugs directly into this socket. The socket also makes mutual control connections between the counter and the recording device.

In the four-line code "0" represents a voltage 15 or more volts negative of ground; "1" represents a voltage at ground or positive of ground.

DECIMAL DIGIT REGISTERED	FOUR - LINE BINARY CODE			
	1st Binary Stage	2nd Binary Stage	3rd Binary Stage	4th Binary Stage
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
No Digit	0	0	1	0

PIN NO. ON DIGITAL RECORDER SOCKET				
	1st Binary Stage	2nd Binary Stage	3rd Binary Stage	4th Binary Stage
Highest order digit read*	Pin 4	Pin 3	Pin 2	Pin 1
2nd highest order digit	8	7	6	5
3rd highest order digit	12	11	10	9
4th highest order digit	16	15	14	13
5th highest order digit	20	19	18	17
6th highest order digit**	24	23	22	21

- * On instruments featuring "times ten" positions of the FUNCTION switch no read-out pins are provided for the left-most DCU, which displays the highest order digit during some measurements. On these instruments the highest order digit represented by a 4-line code is in the front-panel column second from left.
- ** On instruments containing only five read-out DCU's pins 21 thru 24 are permanently wired to produce the "no digit" code which is "0010".

Pin 39 carries a control signal from the counter. This pin is negative during the display period and positive from reset until the end of the next counting period.

Pin 40 is the "inhibit reset" line. When this pin is grounded the counter cannot reset.

Pin 38 is grounded. **Pins 25 thru 37** are not connected to anything.

TIME Jack. The output signal of the clock-pulse generator is available at this jack. The signal consists of positive pulses 2.5 volts in amplitude. The positive transients are accurately spaced at the interval indicated by TIME switch. These transients are recommended for external use as a clock signal. The negative transients occur at the same frequency but are not so accurately spaced. The output impedance is 330 ohms.

FREQ Jack. A sine-wave signal at the oscillator frequency is available at this jack when the EXT-INT switch is at INT. The signal is 10 volts peak-to-peak out of 3000 ohms. When the EXT-INT switch is at EXT., an external signal can be introduced at this jack to substitute for the oscillator signal as described under "GATE Operation".

SCOPE Jack. This jack is connected thru 220K to the suppressor grid of the gate tube. The voltage on the grid determines whether the gate is "open" or "closed". The voltage at the jack is about ground level when the gate is open and about -22 volts with respect to ground when the gate is closed. If the waveform of a signal generating start-stop pulses is displayed on an oscilloscope, the signal at the SCOPE jack may be used to blank the scope during the period the gate is closed. The scope will then display the portion of the wave form whose length is being measured.

ACCESSORY Jack. This socket provides connections to +120 VDC regulated at 10 ma, -110 VDC at 15 ma, +190 VDC at 20 ma and 6.3 VAC at 2 amperes. These supplies may be used to power auxiliary equipment such as transducers. The power supply schematic shows at which terminal each supply is available.

3 Circuit description

NOTE: It is intended that the reader refer frequently to relevant schematic diagrams while reading the material in this section. The Decimal Counting Units are described in an appendix.

GATE & CONTROL CIRCUITRY

The Gate and control Circuitry receive three pulse inputs from the FUNCTION switch (S201): pulses to be counted, start pulses and stop pulses. Pulses to be counted go from Deck G to the signal grid of the Gate tube (V204). The plate of this tube is coupled to the first of the cascaded DCU's. During the period its suppressor grid is at ground the tube amplifies the grid signal and drives the DCU's. In this state the Gate is "open". When the suppressor grid is below -10 volts, the tube is cut off and the Gate may be considered "closed".

The "open-close" voltages on the Gate tube suppressor grid are generated at the right plate of the Control Binary (V203). V203 is a conventional "flip-flop" circuit. Such a circuit has two stable states: left half conducting, right half cut off; and right half conducting, left half cut off. Input pulses or transients applied at various points on the circuit will trigger it back and forth between the two states. When the right half of V203 is conducting, the right plate is 30 volts negative. A negative start transient from the Start Binary, applied at the left plate of V203 and coupled through C210 to the right grid, triggers V203 to its other stable state. In this state the right half is cut off and the right plate rises above ground permitting the Gate tube to conduct.

When a negative stop pulse from Deck E of the FUNCTION switch reaches the left grid of V203 through the diode V201B, V203 is triggered back to the state which holds the Gate closed.

The Start Binary is also a "flip-flop" circuit. It produces a negative start transient at its right plate each time that half begins to conduct. Its left grid is coupled to Deck C of the FUNCTION switch through the diode V201A and C201. When the left half is conducting a negative start pulse at the grid triggers a change to the other stable state producing the output transient. Further negative pulses at the left grid have no effect since that half is already cut off.

When the instrument is ready to begin a counting period the right half of the Control Binary and the left half of the Start Binary are conducting and the Gate is closed. Negative stop pulses received at the left grid of the Control Binary have no effect since this half is cut off. The following sequence occurs. (Refer to Figures 7 & 8).

Time ① A start pulse passes through the injection diode V201A and triggers the Start Binary which in turn triggers the Control Binary to a state which opens the Gate. The DCU's then

count and indicate the number of pulses reaching the Gate.

Time ② A stop pulse triggers the Control Binary to a state which closes the Gate.

At this point, if the instrument is set to operate automatically, the reset circuitry begins to function. The reset control voltage appears at the junction of CR201 and CR203. Its value is determined by the combined effect of the voltage on the right plate of the Start Binary and that on the right plate of the Gate Control Binary. At the close of a counting period (and only then) both these plates are negative. The resulting negative voltage at the junction is applied to the input grid of the Reset Generator through R239.

The Reset Generator (V205) is a two stage amplifier. The first stage (the left half) is a voltage amplifier. The second stage is a cathode follower. The Reset Generator performs two functions. It amplifies the reset control voltage at time ② and it produces a reset pulse upon receiving a signal from the Reset Control at time ③. The negative reset control voltage is amplified, inverted and coupled from the output cathode to the DISPLAY time potentiometer (R247) through R244, CR206 and S204. The positive charge at R247 leaks onto C216. C216 is coupled to the input grid of the Reset Control (V206) through S205B. When this grid rises above a certain voltage, V206 generates an output pulse which initiates step ③, the reset action.

The Reset Control is a monostable multivibrator. In its stable state the right triode is conducting and the left triode is cut off. When the left grid becomes sufficiently positive, that half begins to conduct and right side is cut off momentarily by a negative pulse produced at the left plate and coupled to right grid by C218. The output is a positive pulse at the right plate.

This positive pulse is coupled through R236 and R239 to the input grid of the Reset Generator producing a negative transient at the plate of the first stage which resets all the DCU's and Start Binary. The positive pulse from the Reset Control is also coupled to the cathode of the Start Binary injection diode by R212, C203 and R209. The positive charge on the cathode prevents negative start pulses from reaching the Start Binary until all reset transients have decayed. At time ④, about 15 milliseconds after the reset pulse, the control circuitry is ready to accept another start pulse.

NOTE: When the counter is equipped with the Model 1452 Digital Recorder, the sequence of operations described above is interrupted briefly. A relay in the recorder grounds the input to the DISPLAY time potentiometer from the end of the counting period (time ②) until the recorder has collected count information from the DCU's. (See Figure 9). The connection to the recorder is made through pin 40 of J202.

When the DISPLAY time control is turned fully clockwise the input connection to this potentiometer is broken by S204 and the automatic reset action will not occur. The DCU's hold the accumulated count until the manual RESET button is depressed. Depressing this button actuates S205A and S205B. S205A connects the -110 volt supply to the Reset Generator input grid. S205B connects C216 to the output cathode of the Reset Generator which is then at a high positive voltage. When the button is released the positive charge on C216 flows onto the Reset Control grid and initiates the same reset action that occurs under automatic operation.

SIGNAL

FUNCTION

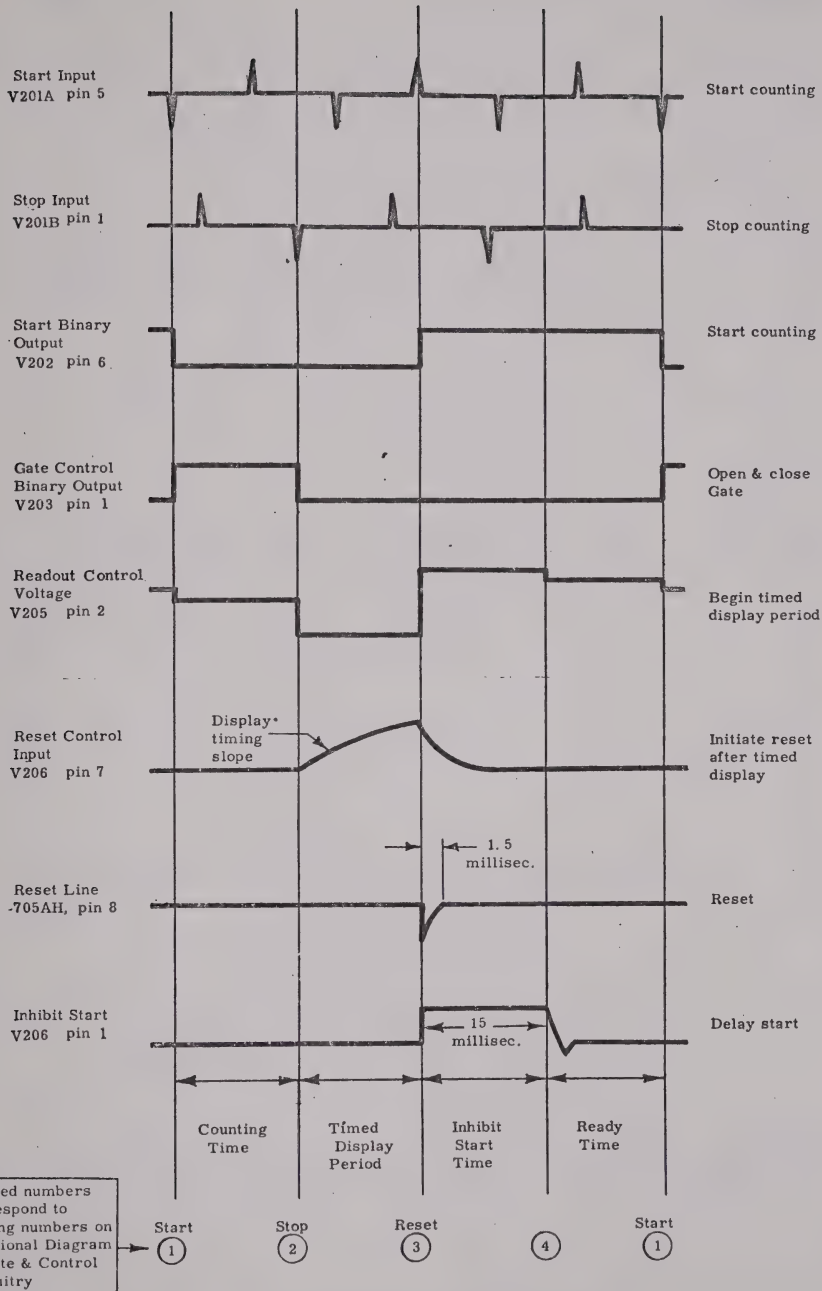
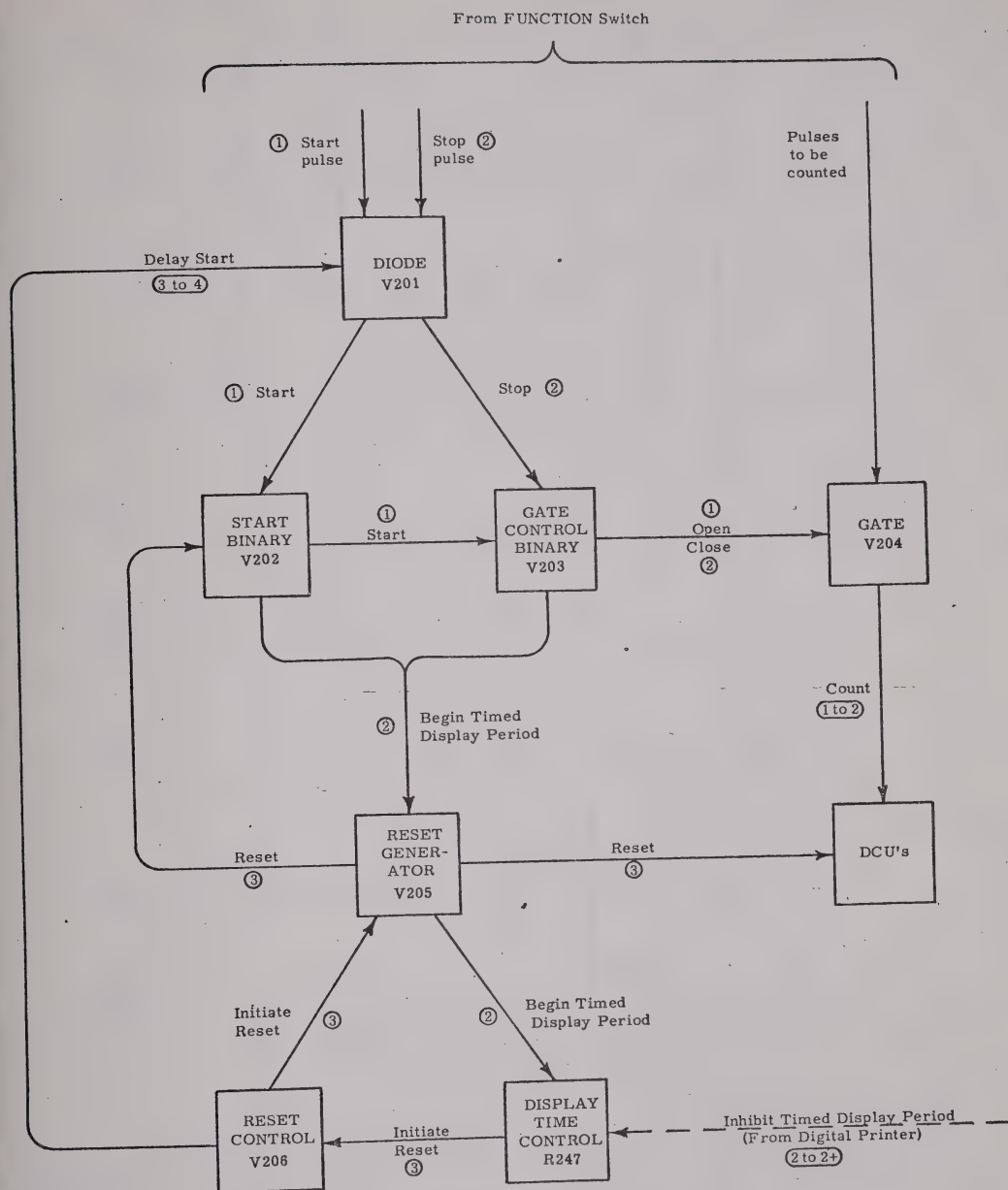


Figure 7. Control Circuit Timing Diagram

WHEN COUNTER IS NOT EQUIPPED WITH DIGITAL PRINTER



NOTE: Circled numbers indicate time of operation as labeled on the Timing Diagrams.

Figure 8 Functional Diagram of Gate and Control Circuitry

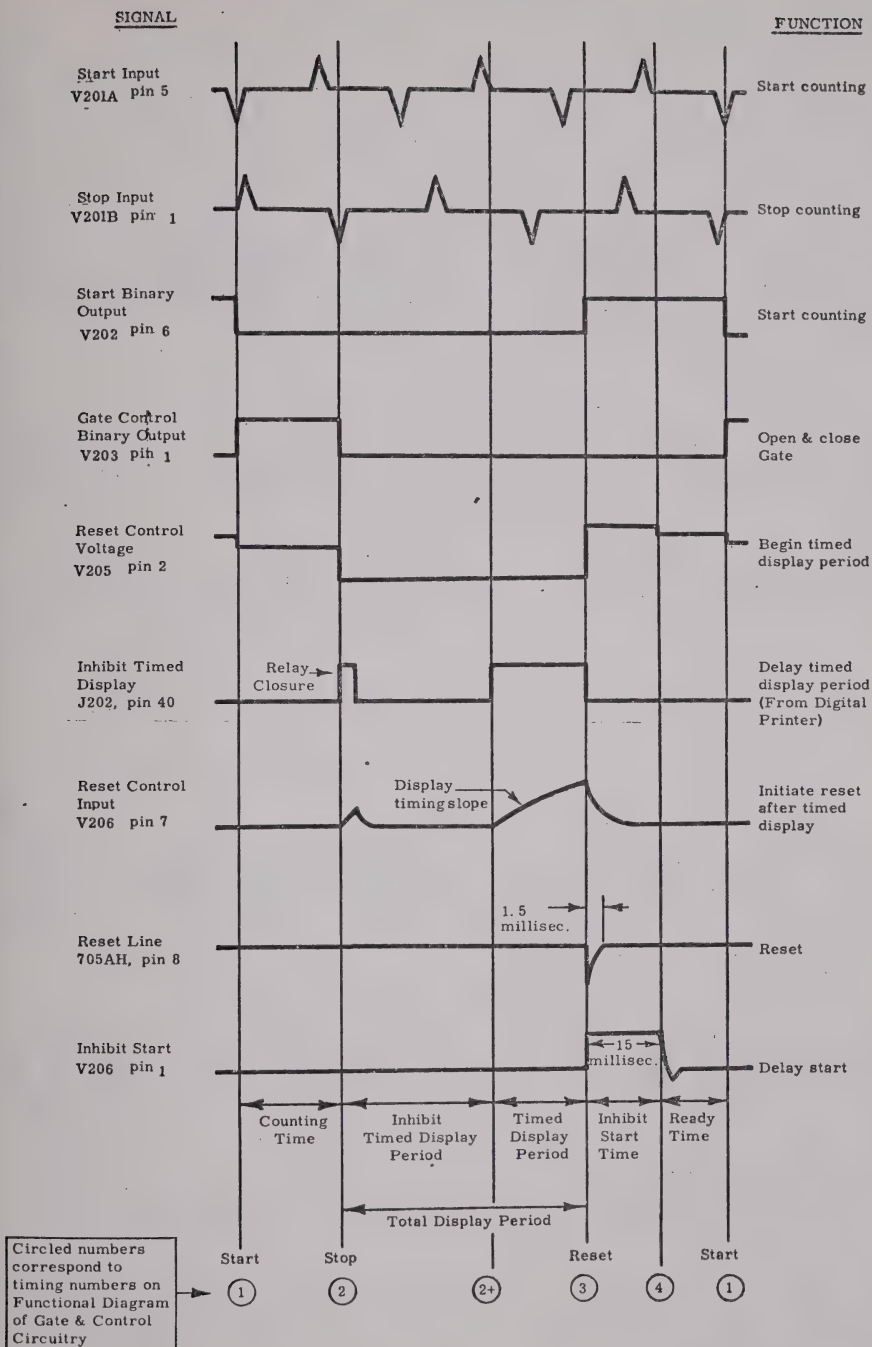


Figure 9 Control Circuit Timing Diagram

WHEN COUNTER IS EQUIPPED WITH DIGITAL PRINTER

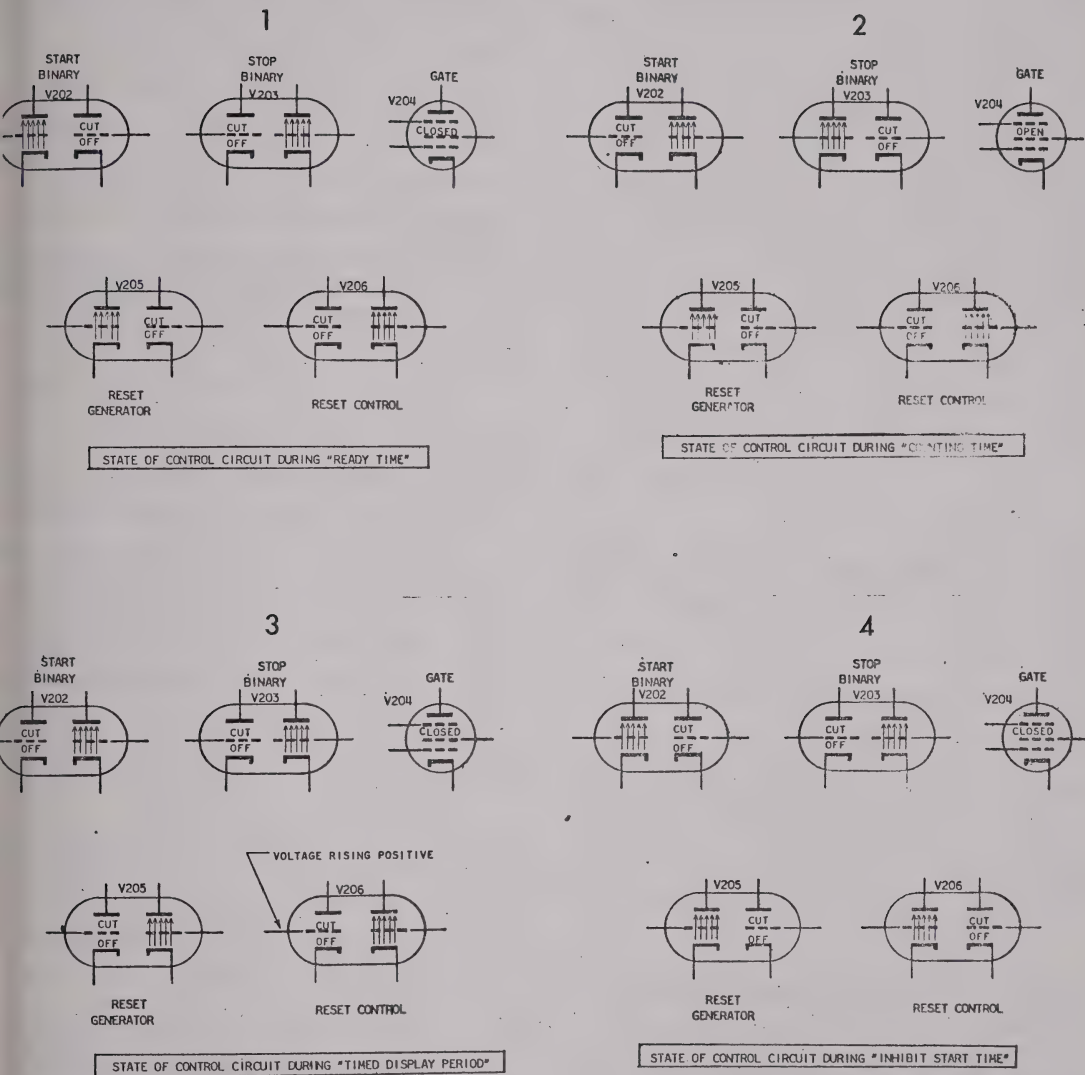


Figure 10 Tube States During the Operating Cycle

INPUT TRIGGER CHANNELS

The input trigger channels are identical. Each channel produces an output pulse each time the attenuated input signal passes a selected voltage level. The output is independent of input waveform. The channel consists of a Schmitt trigger voltage discriminator preceded by a two-stage comparator amplifier. Each input channel is preceded by an attenuator, which divides the input voltage by 1, 10 or 100 according to the position of the ATTENUATION control. The input impedance at all positions is about 10 megohms in parallel with 40 μf . When the ATTENUATION control is at an AC position a .01 μf capacitor (C201) is inserted in series between the INPUT jack and the attenuator.

The comparator amplifier has two stages. The first is a difference amplifier whose output is proportional to the input voltage on the grid of V301A minus a selected constant voltage on the grid of V301B. The TRIGGER VOLTAGE potentiometer (R318) varies the voltage on the grid of V301B between -1 and +1 volts. The second stage (V302) amplifies the double-ended signal received from V301 and converts it to a single-ended low impedance output at the left hand plate. This plate is connected to the input grid of the discriminator.

The voltage discriminator (V303) produces an output pulse each time the input voltage on its left-hand grid passes through a fixed voltage level (about +60 volts). Consider the input to this circuit as an a-c triggering signal superimposed on d-c level. The a-c signal is an amplified reproduction of the voltage variations on the grid of V201A, that is, the attenuated input. The d-c level is determined by the voltage on the grid of V301B, a voltage set by the TRIGGER VOLTAGE potentiometer. As the TRIGGER VOLTAGE control is rotated toward "+", the d-c level is lowered and the discriminator triggers at a higher instantaneous voltage of the a-c signal and at a higher

attenuated input voltage to the channel. When the TRIGGER VOLTAGE control is turned toward "-", the channel triggers at a lower attenuated input voltage.

The discriminator (V303) is a two stage positive feedback amplifier. Feedback from the output stage occurs through the cathode coupling. The loop gain is slightly greater than one so that the circuit is regenerative and tends to assume one of two stable states. The output stage draws a steady current as long as the input grid remains below a certain triggering voltage. When the input exceeds this voltage the output tube is suddenly cut off. When the input voltage returns to a value slightly below the initial triggering voltage the output stage builds rapidly to its original steady current.

The difference between the level at which a positive-going voltage change triggers the circuit and the lower level at which a negative-going voltage change re-triggers it is called the hysteresis of the circuit. At the input to the comparator amplifier the hysteresis is about 0.3 volts. The hysteresis determines the input sensitivity. An attenuated input signal weaker than 0.3 volts peak-to-peak or about 0.1 volts rms will not trigger a series of pulses. This means that any noise at the attenuated input below this level will not trigger extraneous pulses, although it may affect the time at which a pulse occurs.

The primary winding of T301, differentiates the rapid current changes in the output stage to produce a positive pulse at the plate when the circuit is triggered by a positive-going voltage and a negative pulse when triggered by a negative-going voltage. The secondary of T2C1 produces inverted pulses - - a negative pulse when the circuit is triggered on a positive slope and a positive pulse when triggered on a negative slope.

DCU DIVIDER

Deck A of the FUNCTION switch (S201A) selects the signal which is divided by the DCU Divider (AY 201). During all operations other than "times ten" ($\times 10$) operations the output of the last 705AH DCU (AY 202) is coupled to the input of this divider and it functions as the last in the chain, raising the maximum count indication to 10,000,000 on the Model 7360 or to 1,000,000 on the Model 7350. During "times ten" operations the source of "start-stop" pulses is coupled to this divider through a two stage amplifier (V207), and the output of the divider becomes the "start-stop" input to the Control Circuitry. Since it produces an output pulse at every tenth input pulse, the time interval during which pulses are counted is ten times as large as it would be if the

source of "start-stop" pulses drove the Control Circuitry directly. This DCU will not divide a frequency above 100 KC because its pulse resolution time is about 10 μ seconds.

When the divider is part of the counting chain, Deck B of the FUNCTION switch (S201B) couples the reset pulse to pin 8 of the DCU Plug so that it resets to zero. During "times ten" operations Deck F of the FUNCTION switch connects pin 10 to -15 volts to extinguish the DCU indicator lamps and Deck D couples the reset pulse to pin 3 causing the divider to reset to nine. This is done so that the counting period will begin with the first input pulse rather than the tenth, thus eliminating an unnecessary delay.

CLOCK-PULSE GENERATOR

The Clock Pulse Generator provides

1. Pulses of a known frequency which are counted between start and stop pulses to make time measurements.
2. Start and stop pulses separated by a known time interval over which events are counted to make events-per-unit-time measurements.

The circuitry consists of an oscillator, a pulse-shaping circuit, a series of multivibrator frequency dividers, and an output trigger circuit. An additional dividing stage, the DCU Divider, is available to provide a 10-second counting period for E/UT $\times 10$ and SCAN measurements. The shaper stage transforms the sinusoidal output of the oscillator into appropriate pulses. Each of the dividers divides the preceding frequency by ten. Decade frequencies from the shaper and the various dividers are selected by the TIME switch, shaped by the output trigger circuit (the Time Pulse Trigger) and applied to the FUNCTION switch, where they are available for start, stop or pulses to be counted.

OSCILLATOR

A crystal controlled oscillator provides a reference frequency which is divided to obtain clock pulses of various frequencies. The Model 7360 uses a 1MC oscillator and the Model 7350 uses a 100KC oscillator. In either case the oscillator consists of a two-stage amplifier with a Wheatstone bridge feedback circuit. The first stage (V401B) is a triode with an L-C tuned plate load. The triode operates as a voltage amplifier and drives the second stage V401A, a pentode which operates as a cathode follower power amplifier.

Feedback is taken from across the cathode load resistors of the pentode and fed to the inputs of a Wheatstone bridge in the cathode-grid circuit of triode. The upper arms of the bridge, consisting of R440, crystal Y401, C409 and C410, supply negative feedback to the triode grid. The lower arms consisting of RXXX and a non-linear resistor (the thermistor I401) supply positive feedback to the triode cathode. As the amplitude of the triode plate signal increases, the pentode supplies more

power to the bridge and the current through the thermistor increases raising its resistance. The higher resistance alters the voltage dividing ratio of this arm of the bridge so that less positive feedback is applied to the cathode and the amplitude of the triode plate signal is lowered. This action provides great frequency stability by limiting the amplitude of oscillation to the linear range of the circuit.

The crystal is tuned with the temperature stable capacitor C410. By adjusting the capacitor the output frequency may be shifted as much as .001%. The impedance of the crystal (Y401) varies from unit to unit. The value of RXXX has been chosen at the factory so that the voltage dividing ratio of the bridge will produce the proper amount of feedback. The triode plate circuit (L401, C403) is tuned to resonance at the oscillator frequency.

SHAPER

The shaper stage (V402) amplifies and shapes the oscillator output for use as an input to the control circuitry and the dividers. The circuit is a voltage discriminator which operates in the same way as that discussed under "Input Trigger Channels". The trigger voltage level is set by adjusting R414. L402 differentiates the rapid current changes at the output plate to produce fast positive and negative pulses. The negative transients drive the first divider through the twin diode V602. The pulse output is conducted to the TIME switch (where it may be selected to drive the Time Pulse Trigger) and directly to the FUNCTION switch where it provides pulses to be counting during the TEST operation and a start pulse for the COUNT operation.

DIVIDERS

The dividing chain consists of cascaded monostable multivibrators. Each produces one output pulse for every ten input pulses. The Model 350 has five dividers which scale its 100KC oscillator frequency to 1 cps. The Model 7360 carries

another divider preceding the last five which scales its LMC oscillator frequency to 100 KC. Although the LMC divider (V501, V502) carries additional circuitry to fit it for high-speed operation, it operates in essentially the same way. The action is described with reference to V604. With no input the circuit is stable; the right-hand side is conducting because its grid is connected to +120 VDC and the left-hand side is cut off. A negative transient reaching the input capacitor (C605) is coupled through R617 and R618 to each of the two plates. The negative pulse produced on the left plate is coupled by C609 to the right grid. It appears as an amplified positive pulse at the right plate, which is coupled to the left grid through C607. The left-hand side of the tube conducts, driving the left plate and the right grid even further negative. This regenerative action produces a quasi-stable stage in which the right side is cut-off and the left side is conducting. In this state the voltage on the right grid (called the "timing grid") is rising relatively slowly as the voltage at the wiper of potentiometer R656 charges the timing capacitor (C609) through R645. At the same time negative input pulses at the right plate reach the left grid through C607 and appear as large positive pulses at the left plate. These pulses reach the timing grid through C609 and appear superimposed on the rising voltage curve there. (See Figure 11). When one of the positive pulses brings the timing grid above cut-off, the right side conducts and a reverse regenerative action returns the circuit to its original stable state. The slope of the rising grid voltage curve determines which of the successive positive pulses will rise above cut-off. The slope changes when the charging voltage at the wiper of R656 is raised or lowered. R656 is adjusted so that the ninth pulse rises above cut-off. The tenth pulse returns the circuit to the quasi-stable state.

In the interval between the ninth and tenth pulses the right side is conducting and the right

plate is negative. The negative transient produced is the useful output of the divider. It drives the next divider stage through C609 and is conducted to the TIME switch where it is available as a clock signal.

The additional circuitry associated with the 1MC divider (V501) speeds up its response. V501 is a multivibrator which operates just as V604. V502A is a cathode follower inserted between the left plate of the multivibrator and timing grid. Its function is to discharge C504, the timing capacitor, within the brief 1 μ second output pulse period so that the capacitor will pass the next positive pulse to the grid. V502B functions as a diode clamp on the left grid of the multivibrator. It prevents this grid from going so far negative during the 1 μ second pulse output period that it will not rise above cutoff when the next positive pulse reaches it.

TIME PULSE TRIGGER

The TIME switch selects a negative output transient from one of the dividers stages and feeds it to the Time Pulse Trigger (V601). The Time Pulse Trigger is a voltage discriminator which operates in the same way as that described under "Input Trigger Channels". Output clock pulses produced at L601 are coupled to the FUNCTION switch.

POWER SUPPLY

A conventional system consisting of a transformer, two selenium bridge rectifiers and a filter network produces the +190 and -110 volt unregulated supply. Ripple on these supplies is about 10%.

The regulated +120 volt supply is obtained by dropping 190 volts through V102. The voltage drop across V102 is controlled by V101 in such a way as to maintain a constant voltage at the regulated output. A voltage dividing network (R106, R107, R113) is connected between the regulated supply and a point held 60 volts negative of ground by a

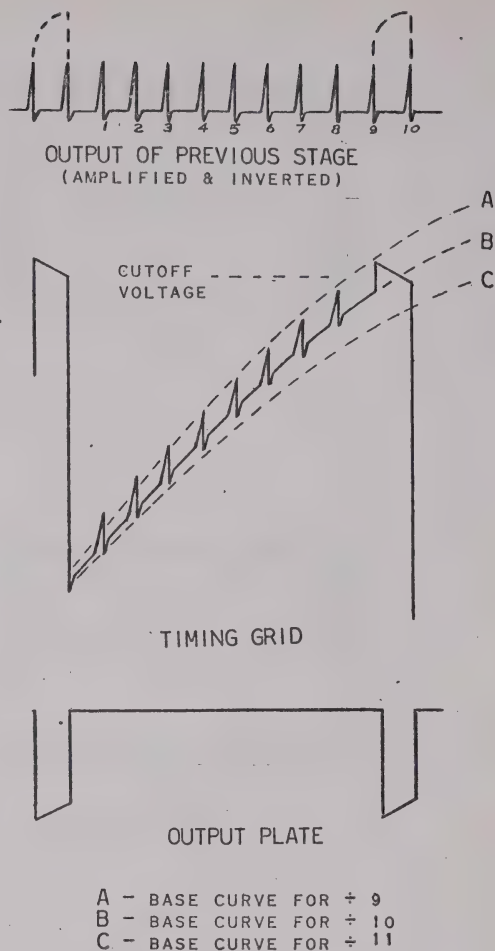
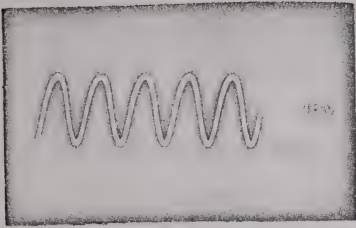


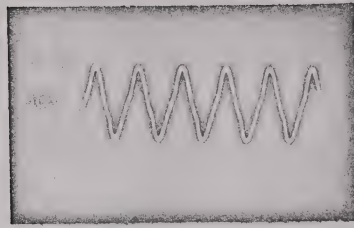
Figure 11 Divider Stage Waveforms

diode (CR103). The control grid of V101 is connected to a point on this network which is slightly below ground when the regulated supply is 120 volts. When the regulated supply varies from 120 volts, the voltage on the control grid varies proportionately and V101 delivers a signal to V102 which opposes the change.

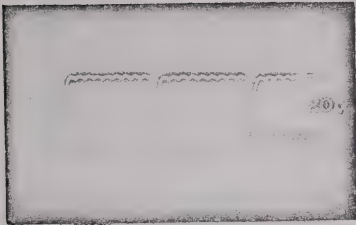
The -60 volts supply is shunt regulated by V104. Since this tube operates as a cathode follower the output voltage drawn from the cathodes remains very near the 60 volts maintained on the grids by the diode.



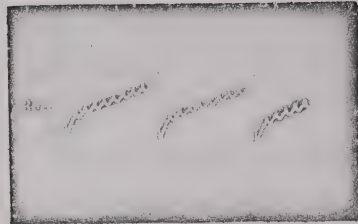
1. 1 MC Oscillator Output
V402, pin 2



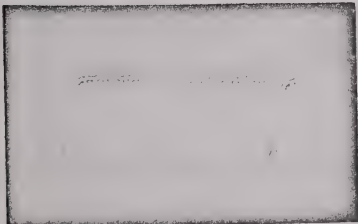
2. Shaper output, V402, pin 1



3. 1 MC Divider Output Junction
of R502 and R503 (Not on Model 7350)



4. 1 MC Divider timing grid.
V501 pin 2 (Not on Model 7350)

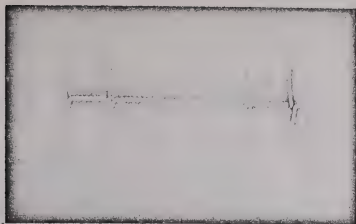


5. 100KC Divider Output
V603, pin 6

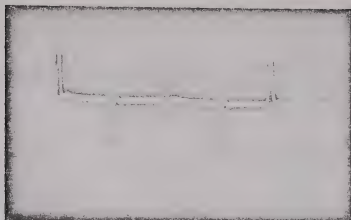


6. 100KC Divider, Timing Grid
V603, pin 7

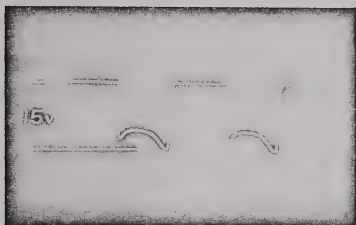
Figure 12a Typical Waveforms



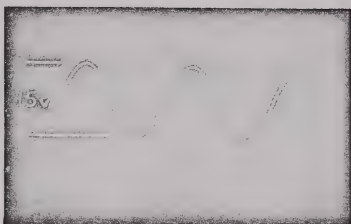
7. Time Pulse Trigger
100 KC output, V601, pin 1



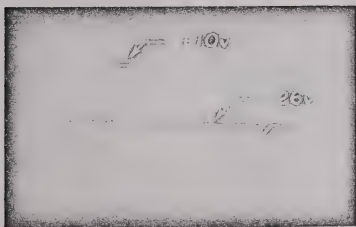
8. Discriminator output
V303, pin 1



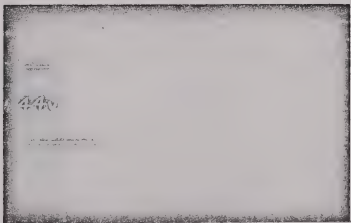
9. Discriminator amplifier plate.
100 KC signal V303, pin 6



10. Discriminator input. 100 KC
signal, V303, pin 6

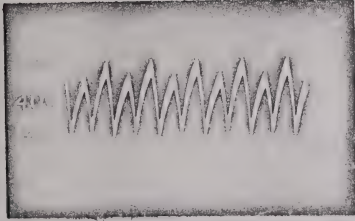


11. Gate Control Binary output.
V203, pin 1

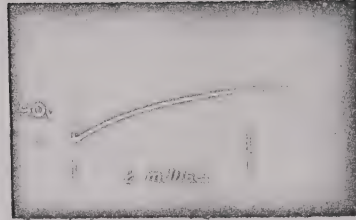


12. Start Binary output.
V202, pin 1

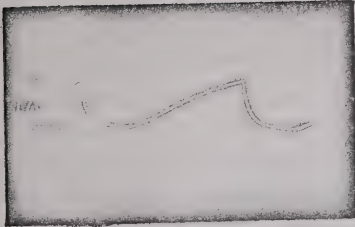
Figure 12b Typical Waveforms



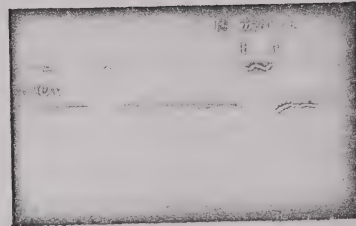
13. Signal gate output.
1 MC signal. V204, pin 5



14. Reset pulse. Junction of
C215 and CR205



15. Reset Control input.
V206 pin 7



16. Reset Control output.
(minimum display time)
V206, pin 1



17. Reset Control signal to
Digital Recorder.
J202, pin 39

Figure 12c Typical Waveforms

4 Maintenance

ROUTINE ADJUSTMENTS

OSCILLATOR

The oscillator frequency can be varied by rotating the XTAL ADJUST control on the top side of the counter chassis. Adjust the control until the oscillator signal which appears at the FREQUENCY jack comes to zero beat with a WWV signal or some other highly accurate frequency standard.

OSC. ADJ.

The oscillator is adjusted to maximum stability by a slug-tuned inductor (L401) in the plate circuit of the oscillator triode. L401 is located on under side of chassis near the SHAPER LEVEL potentiometer. Normally, an adjustment is required only when a tube or other component has been changed. Adjust the slug very carefully for a maximum signal at the FREQUENCY jack.

A third oscillator adjustment should be made whenever the crystal is replaced. Measure the signal at the FREQUENCY jack with a VTVM. Vary the resistance between the thermistor and ground by adding resistors in series or parallel with RXXX until the meter reads 4 volts rms.

Shaper

SHAPER

The shaper stage in the clock-pulse generator is a voltage discriminator similar to those in the Input Trigger Channels. The SHAPER LEVEL control, located on the top side of the counter chassis, sets the trigger voltage at the input to this circuit. To adjust, set the FUNCTION switch at TEST. Find the limits of the range of adjustment in which the instrument continues to count. Set the control at the center of this range.

DIVIDERS

The dividers should be aligned occasionally by adjusting the potentiometer controls located on a narrow strip above the counter chassis and labeled ADJ. 1 SEC; ADJ 10^{-1} SEC; etc. Make the adjustments while the line voltage to the instrument is equal to the voltage it will be operated on. Place the FUNCTION switch at TEST. Then proceed as follows:

1. On Model 7360, turn TIME switch to 10^{-5} and measure the d-c voltage between test point E5 and ground. Rotate the ADJ. 10^{-5} SEC control to the extremes of the range in which a reading of 10 appears on the DCU's noting the test point voltage at each extreme. Then adjust the control until the test point voltage is midway between the extreme values.
On Model 7350, turn TIME switch to 10^{-4} and measure the d-c voltage between test point E4 and ground. Rotate the ADJ 10^{-4} SEC control to the extremes of the range in which reading of 10 appears on the DCU's, noting the test point voltage at each extreme. Then adjust the control until the test point voltage is midway between the extreme values.
2. On Model 7360, turn TIME switch to 10^{-4} . Measure voltage at point E4. Rotate ADJ 10^{-4} SEC control to extremes of range which reads "100", noting test point voltages at extremes. Adjust the control until the voltage is halfway between extremes.

1) Let the tubes, etc. "cook" in for five or six hours before making the adjustment.

On Model 7350, turn TIME switch to 10^{-3} . Measure voltage at E3. Rotate ADJ 10^{-3} SEC control to extremes of range which reads "100", noting test points voltages at extremes. Adjust control until voltage is halfway between extremes.

3. On Model 7360, with TIME switch at 10^{-3} set ADJ 10^{-3} SEC control similarly but to center of voltage range in which either 1000 or 999 appears.

On Model 7350, with TIME switch at 10^{-2} , set ADJ 10^{-2} SEC control similarly but to center of voltage range in which either 1000 or 999 appears.

4. Adjust the remaining controls in order to the center of the 10,000 or 9,999 range, the 100,000 or 99,999 range, and (on the Model 7360) the 1,000,000 or 999,999 range.

The adjustment of each divider affects the adjustment of the others slightly. Therefore after the initial adjustment outlined above, a final adjustment should be made. With the FUNCTION switch at TEST, set the TIME switch to 10^{-1} .

On the Model 7360, a reading of 100,000 or 99,999 will appear. Adjust in turn ADJ 10^{-5} SEC thru ADJ 10^{-1} SEC to the center of the corresponding test point voltage range within which either of these readings appears. Then set the TIME switch at 1 and rotate ADJ 1 SEC to the center of the voltage range at E0 within which either 1,000,000 or 99,999 appears.

On the Model 7350, a reading of 10,000 or 9,999 will appear. Adjust in turn ADJ. 10^{-4} SEC thru ADJ. 10^{-1} SEC to the center of the corresponding test point voltage range within which either of these readings appears. Then move the TIME switch to 1, and rotate ADJ. 1 SEC to the center of the voltage range at E0 within which either 100,000 or 99,999 appears.

REGULATED 120 VOLT SUPPLY

Measure the supply voltage at the test point labeled "+120V" with an accurate voltmeter. Adjust +120 V ADJUST, located on the top side of the counter chassis, for a reading of 120 volts.

TIME PULSE TRIGGER

The Time Pulse Trigger (V601) is a Schmitt trigger circuit. The TIME TRIGGER LEVEL control varies the instantaneous voltage at which an input signal triggers the circuit from one state to another. Whenever the tube is replaced adjust the control until, with no input signal, the potential on the input grid (Pin 2) is -1 volts with respect to the cathode (pin 7). Check TEST operation under two conditions: (1) line power reduced to 105 volts and TIME switch at 1 second (2) normal line voltage and TIME switch at 10^{-6} seconds. An incorrect adjustment will cause either a reading of 100,000 rather than 1,000,000 at the 1 second position or no reading instead of "1" on the 10^{-6} seconds position. If necessary, re-adjust the control until correct readings are obtained under both conditions.

ATTENUATOR ADJUSTMENTS

Two ceramic trimmer capacitors on each attenuator assembly must be adjusted properly to prevent the attenuator from distorting the input signal. When the counter chassis is upside down and the attenuator shafts are pointing at the viewer, the capacitor on the right side of each attenuator is C303 and that on the left C302. To adjust, apply a 500 cps square wave signal at one of the counter INPUT jacks. Observe the corresponding amplifier output at Pin 1 of V302 with a 100 KC band-width oscilloscope. Turn the attenuator to 10 on the AC side. Adjust the input signal to about 1 volt peak-to-peak. Adjust the TRIGGER VOLTAGE control to any position in which the channel triggers. Adjust C303 for a square wave output. Then, turn the attenuation control to 100 on the AC side and adjust the input signal to about 10 volts peak-to-peak. Adjust C302 for a square wave output.

TROUBLE-SHOOTING

The following test equipment is necessary to service the instrument effectively:

1. An oscilloscope, sensitivity 1/4 volt, bandwidth 5 MC, preferably direct coupled.
2. A signal generator, frequency range 100 cps to 1MC, output at least 100 mv rms.
3. A vacuum tube voltmeter.

When the instrument fails to perform properly, first make sure that it is being operated correctly. Some common errors in operation are:

1. TRIGGER VOLTAGE control positioned incorrectly.
2. ATTENUATION control set incorrectly.
 - (a) Wrong choice of AC or DC coupling.
 - (b) Attenuated signal too strong or too weak.
3. SLOPE switches set incorrectly. (see "PERFORMING SPECIFIC OPERATIONS" for correct setting for each operation.)
4. Input signal coupled to wrong jack.
5. FUNCTION switch set at "times ten" position when original start-stop frequency is above 100 KC. For example:
 - (a) FUNCTION switch at E/UT x 10 and TIME switch at 10^{-6} .
 - (b) FUNCTION switch at A/B x 10 when B frequency is above 100 KC.
6. Wrong TIME switch setting
 - (a) Unit of time measurement too large to measure a brief period under PERIOD operation.
 - (b) Time interval too short to measure a low frequency under events-per-unit-time operation.
7. Too much noise on input signal.

When it is certain the instrument is functioning properly, first check the power supply vol-

tages to see that they lie within the limits listed below.

Supply	Limits of average level	Acceptable ripple
Unreg. pos.	+190v $\pm$ 10%	15v peak-to-peak
Unreg. neg.	-110v $\pm$ 10%	5v peak-to-peak
Reg. Pos.	+120v to accuracy of adjustment	0.1v peak-to-peak
Reg. Neg.	-55v to -65v	0.5v peak-to-peak

If the supply voltages are adequate, the next step is to trace the failure to one of the major components. This can be done by observing the start, stop and count pulses at Decks C, E & G respectively of the FUNCTION switch. If the signals at these points approximate the proper output waveforms of the pulse sources, the trouble lies in the Gate and Control Circuitry or the indicating DCU's. Refer to the schematic diagram, Figure 13, to determine the source of pulses when the FUNCTION switch is in a particular position. If a deficient pulse is found the trouble lies in that pulse source.

When the trouble has been traced to one of the major components consult the Circuit Description section of this manual and the waveforms of Figure 12 for guidance in locating the specific fault. The Input Trigger Channels may be conveniently checked by observing whether or not a pulse is produced as the TRIGGER VOLTAGE control is rotated from one extreme to the other and back.

Tubes, chokes, germanium diodes and pulse transformers are the most common sources of trouble. A transconductance tube tester will not always detect a faulty tube and, conversely, the tester may reject a tube which is functioning

properly. Although the circuits are designed for wide tube variation, avoid swapping tubes or wholesale replacement. An aged tube is generally more reliable than a new tube, because catastrophic failure usually occurs early in the life of a tube if at all. An aged tube undergoes only a gradual loss of transconductance, emission, etc.

The Sylvania 6U8 tube is recommended for use in trigger circuits V402, V601 and V303. (There are two V303 stages -- one in each input trigger channel.)

PREVENTIVE MAINTENANCE

Since a tube tester will not detect tubes which are likely to cause trouble and it is undesirable to replace tubes wholesale as they grow old, other methods must be used to forestall failures. The most effective method is "marginal checking". In its simplest form this consists in causing intermittent or latent failures to manifest themselves by operating the instrument at exceptionally high or low line voltages. A variable auto-transformer may be used to manipulate the line voltage.

5 Parts list

This parts list is compiled to assist the customer to replace a component which might become defective. Any part which is not adequately described in the schematic diagrams is included here. Parts listed are used in both the Model 7360 and the Model 7350 unless otherwise specified.

TUBES

<u>Type</u>	<u>Quantity</u>	<u>Type</u>	<u>Quantity</u>
5965 Model 7360	15	6080	1
Model 7350	13	6350	1
6U8*	5	6AS6	1
6AL5	2	5687	1
6AU6	1		

<u>Part No.</u>	<u>Stock No.</u>	<u>Description</u>	<u>Mfr. & No.</u>
-----------------	------------------	--------------------	-----------------------

RESISTORS

06	1-6257	1 M, 1 W, 5 % Deposited Carbon Film	IRC
13	1-6258	500 K, 1 W, 5 % Deposited Carbon Film	IRC
247	1-2956	Potentiometer 10 M, W/ Switch	CRL BA026-000
318	1-5573	Potentiometer 10 K, Tapped at 40% CW Rotation	Allen-Bradley JU 1031 SD 3048
511	1-6012	560 K, 1 W, 5 % Deposited Carbon Film	IRC
515	1-4258	50 K, 1 W, 1 % Deposited Carbon	IRC

The Sylvania 6U8 tube is recommended for use in trigger circuits V402, V601 and V303. (There are two V303 stages -- one in each input trigger channel.)

<u>Detail No.</u>	<u>Stock No.</u>	<u>Description</u>	<u>Mfr. & No.</u>
R642	1-6010	3.9 M, 1 W, 5 % Deposited Carbon	IRC
R645		Same as R642	
R648		Same as R642	
R651		Same as R642	
R654		Same as R642	
R660	1-3846	33 K, 1 W, 1% Deposited Carbon	IRC

CAPACITORS

C101	2-4254	125 μ fd, 350 v	Mallory FP140
C104	2-3982	8 μ fd, 250 v	Sangamo MT 2508
C106	2-5630	125 μ fd, 350 v, Electrolytic	Sangamo PL 35125
C110		Same as C104	
C202	2-2138	25 μ fd, Mica	Sangamo RR1425
C203	2-2760	.25 μ fd, 400v, Paper	Sangamo 3004025
C205		Same as C202	
C207		Same as C202	
C208		Same as C202	
C210		Same as C202	
C211	2-1847	5 μ fd, Mica	Sangamo RR 1550
C214	2-5691	.1 μ fd, 400v, Metalized Paper	Hopkins Eng. P140
C215		Same as C214	
C216	2-6122	1 μ fd, 200 v	Sprague 2 TM-M1
C220	2-2136	100 μ fd, Mica	Sangamo RR 1310
C221	2-2141	50 μ fd, Mica	Sangamo RR 1450
C222		Same as C220	
C302	2-2326	5-25 μ fd, Variable	Erie 557-5
C303		Same as C302	
C304	2-1939	20 μ fd, Mica	Sangamo RR1420
C305	2-6474	3300 μ fd, Mica	Sangamo CR 1233
C306	2-2608	300 μ fd, Mica	Sangamo RR1330

<u>Detail No.</u>	<u>Stock No.</u>	<u>Description</u>	<u>Mfr. & No.</u>
C307	2-2607	33 μ fd, Mica	Sangamo RR 1433
C308	2-2608	300 μ fd, Mica	Sangamo RR 1330
C309	2-2082	10 μ fd, Mica	Sangamo RR 1410
C312		Same as C309	
C403 Model 7350	2-3246	600 μ fd, Mica, 500v	Sangamo KR 1360
Model 7360	2-3620	120 μ fd, Mica	Sangamo 1312
C407	2-2135	15 μ fd, Mica	Sangamo RR 1415
C408	2-3948	.1 μ fd	CD Tiny Chief
C409	2-3106	33 μ fd	Erie NPO
C410 Model 7350	2-1501	0-100 μ fd. 500v 5%	James Type J-100G # 26100 LN
Model 7360	2-5706	2-18 μ fd, Variable	JFD VC4
C501	2-2082	10 μ fd, Mica	Sangamo RR 1410
C503	2-2138	25 μ fd, Mica	Sangamo RR 1425
C504	2-3879	56 μ fd, 5 %, 500vPPM	Vitramon Type 70
C602	2-2135	15 μ fd, Mica	Sangamo RR 1415
C604	2-2082	10 μ fd, Mica	Sangamo RR 1410
C605	2-2138	25 μ fd, Mica	Sangamo RR 1425
C606	2-3879	56 μ fd, 500 v, 5%	Vitramon Type 70
C607		Same as C604	
C608		Same as C605	
C609	2-3574	470 μ fd, 500 v, 5 %	Vitramon
C610		Same as C604	
C611		Same as C605	
C612	2-42 06	.0047 μ fd, 5 %	Sprague 186-P-472 - 53S3
C613		Same as C604	
C614		Same as C605	
C615	2-5603	.047 μ fd, 5 %	Sprague 186-P-473 - 53S3
C616		Same as C604	
C617	2-5604	.47 μ fd, 5 %	Sprague 186-P-474 - 53S3

<u>Detail No.</u>	<u>Stock No.</u>	<u>Description</u>	<u>Mfr. & No.</u>
OTHER COMPONENTS			
B101	9-3389	Fan Motor	General Industries
CR101	8-5632	Rectifier	Berkeley Division
CR102	8-5633	Rectifier	Berkeley Division
CR201	8-5579	Crystal Diode 9GA2	IRC
CR202, CR203 & CR206			
F101 Model 7350	2-2213	Fuse 3 Amp. Slo Blo	Littlefuse 3AG
Model 7360	7-5824	Fuse 4 Amp. Slo Blo	Littlefuse 3AG
F102 Model 7350	2-2213	Fuse 3 Amp Slo Blo	Littlefuse 3AG
Model 7360	7-5824	Fuse 4 Amp. Slo Blo	Littlefuse 3AG
I101	21-5861	Lamp 24v; .033a -.047a	Western Electric A-1
J202	17-5620	Connector 40 Pin Chassis Mtg.	Cannon DPX-40-34S
L201	3-6164	Choke 500 μ Henry	Wilcor #1500-15
L401 Model 7350	3-6344	Choke 2.5-5 MilliHenry	Berkeley Division
Model 7360	3-3511	Choke 190-210 μ Henry	Berkeley Division
L402	3-6328	Choke 240 μ Henry	Wilco 3240-15
L601		Same as L401	
S201	12-6029	Switch 4 Sec., 11 Position	Berkeley Division
S205	12-2600	Switch DPDT Pushbutton	Switchcraft #FF1006
S301	12-5698	Switch 2 Sec., 7 Pos.	Berkeley Division
S601	12-5700	Switch 7 Pos. 1 Pole	Berkeley Division
T101	6-6333	Power Transformer	Berkeley Division
T301	6-5821	Pulse Transformer Ferrite Core 300 μ H., .25 μ sec. pulse width	Berkeley Division
Y401 Model 7350	13-6325	Crystal 100 KC W/ Oven	Berkeley Division
Model 7360	13-5696	Crystal 1 Mc W/ Oven	Berkeley Division

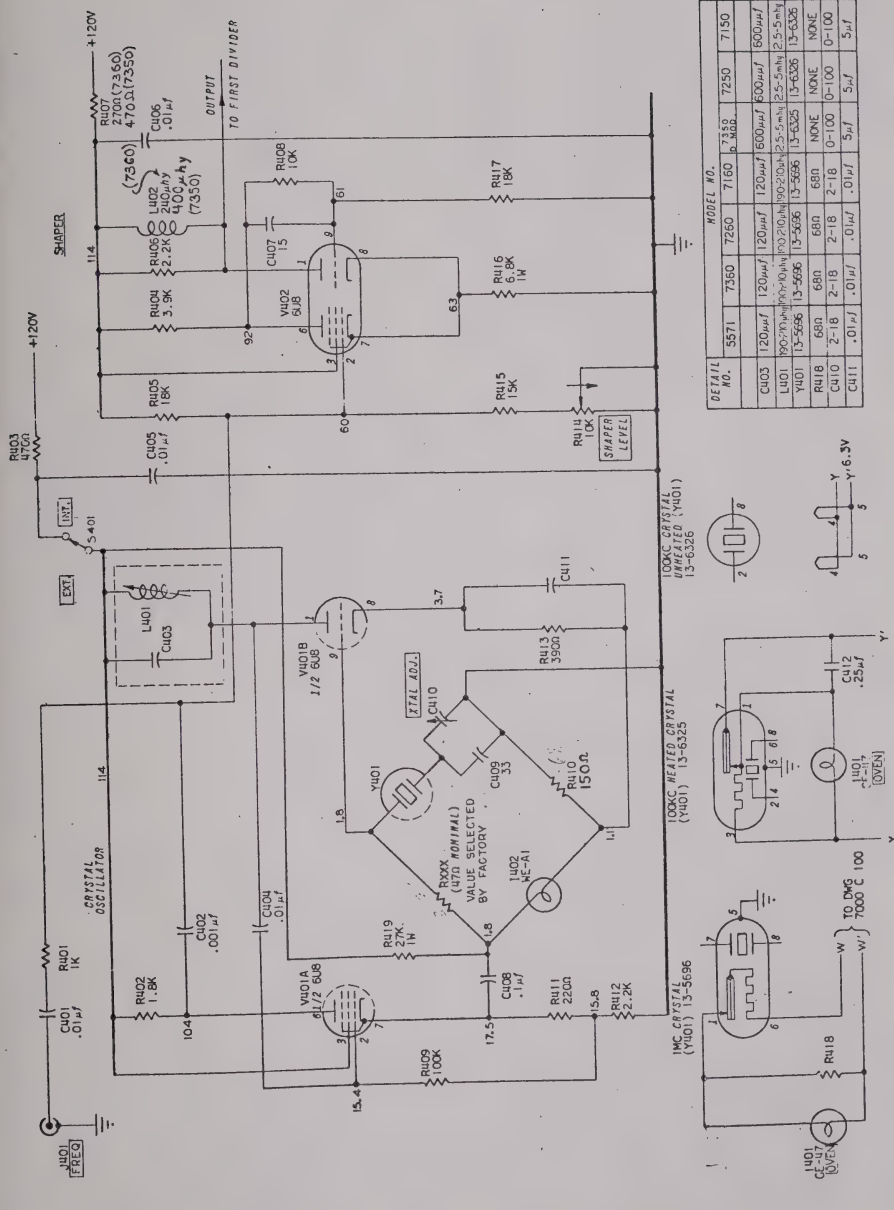
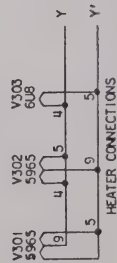


FIGURE 14
SCHEMATIC DIAGRAM
MODELS 7360 & 7350
OSCILLATOR & SHAPER

NOTE:

RESISTORS:
1/2W UNLESS OTHERWISE NOTED.
WATTAGE
5% UNLESS OTHERWISE NOTED.
TOLERANCE

CAPACITORS:
IN μ mf UNLESS OTHERWISE NOTED.
CAPACITY



CAPACITY
VOLTAGE RATING

LOT 28
3-27-56

FIGURE 17
SCHEMATIC DIAGRAM
MODELS 7360 & 7350
INPUT TRIGGER CHANNEL

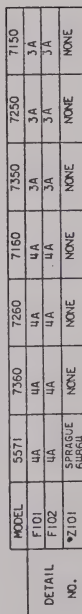


Figure 18 Power Supply Schematic

Section II

INSTRUCTION MANUAL

Model 705AF
DECIMAL COUNTING UNIT

Lot 6 and above. —

Section 1

INTRODUCTION

The Model 705AF Decimal Counting Unit is a direct-reading, plug-in electronic counter with facilities for extracting information from the DCU to operate other electronic devices. The number of counts received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. any number of these units can be connected in cascade (the output of one unit driving the next), forming a counter whose total count capacity depends only on the number of DCU's. Thus, five units will count to 99,999 resetting to 00,000 on the 100,000th pulse (see Figure 1).

Specifications

Count Indication	Direct reading Decimal presentation
Power Requirements	Heater: 6.3 v. at 1.2 amps. Plates: 300 v. at 15 ma.
Input Requirements, recommended	Negative pulse 100 v. peak amplitude
Rise Time	Less than 1 μ second
Duration	At least 2 μ seconds
Output Characteristics*	Designed to drive Model 705A or 705AF
Resolution of Paired Pulses	5 μ seconds
Reset to Zero	Instantaneous through opening of grid
Maximum Counting Rate	100,000 cps
Construction	Plug-in unit, 11-pin socket

Output information is also presented at four of the pins on the 11-pin plug as high or low voltages, depending upon the number of counts the DCU has received.

Section 2 OPERATION

Installation

Normally, Decimal Counting Units are installed in Berkeley instruments. No special instructions are necessary. For unusual installations, we invite your inquiry.

The reset pin (pin #3 on the 11-pin plug) should be connected to ground through a normally-closed switch or relay contacts. To reset the unit, open the contacts momentarily. Care must be taken to avoid coupling voltage surges into the input or power supply circuits.

Operation

Power requirements:

Plates:	250 volts to 350 volts (nominal 300 volts at 15 ma)
Filaments:	6.3 volts at 1.2 amperes

Input requirements:

If the unit is powered by an unregulated supply, the drive amplitude should vary with the supply voltage. A negative transient is required to drive the unit, either a square wave or a rectangular pulse at least two microseconds wide. The pulse amplitude depends on the rise time. For a rise time of 0.5 microseconds (measured between ten and ninety percent values), the pulse amplitude should be between 75 and 135 volts; for a two microsecond rise time, an amplitude of 120 to 165 volts should be used. Rise times of one microsecond or less, pulse amplitudes of 100 volts and a 300 volt supply offer optimum performance. The input load presented by either unit during triggering is equivalent to 100 μf in series with 15,000 ohms.

Output requirements:

The output is a rectangular waveform presented at the output terminal as a change in d-c voltage (see Figure 4). Between "0" and "6", the output is 55 volts; "6" and "7", 125 volts; and "8" and "9", 135 volts. The slip between "7" and "8" is caused by an interpolation network.

The load imposed on the unit must not be more than 300K to ground or 6K in series 100 μf .

Section 3

THEORY OF OPERATION

Basic Design

The basic circuit of the Model 705AF is a modification of the Eccles-Jordan trigger circuit with two stable states, referred to as a binary. It is a two-stage amplifier with the output of the second stage connected to the input of the first, as shown in Figure 2.

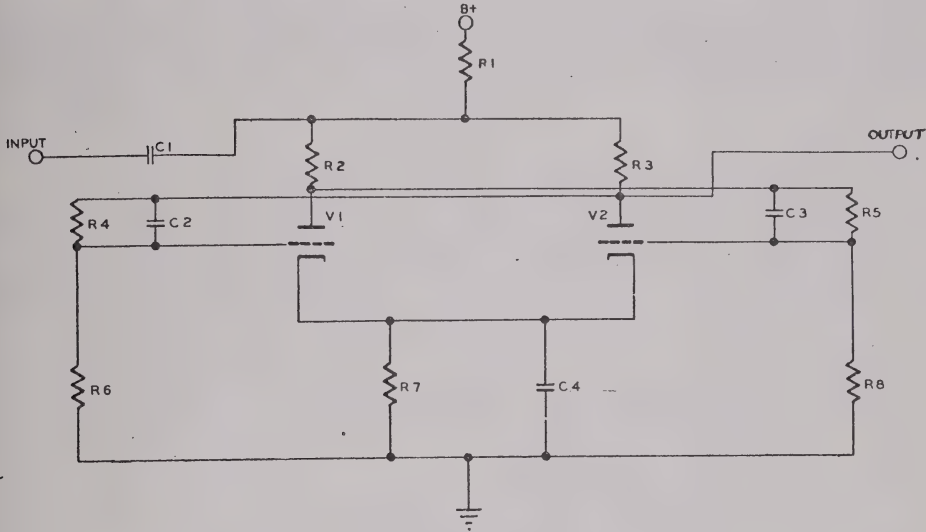


Figure 2, Basic Circuit, Model 705AF

With no input, the loop gain is less than one, and the circuit is in one of its two stable states, i. e., either V2 conducting and V1 cut off, or vice-versa. The circuit is triggered from one state to the other by making the loop gain greater than one. The binary is coupled to a single trigger source through C1 and R1 in such a way that the effect of the trigger is different on the two stages, depending on which stage is conducting. For example, assume that V2 is conducting and V1 is cut off. If a negative pulse is applied to the input, there is a drop in the plate voltage of V1. This drop in voltage is transmitted through a cross-over network (R5, R8, C3 and the grid-to-ground capacitance of V2) and applied to the grid of V2. The plate voltage of V2 then starts to rise, carrying with it the grid of V1. When the input pulse is of sufficient amplitude, the loop gain becomes greater than one, and the binary is triggered to its other stable state, V1 conducting and V2 cut off.

The next input pulse reverses the process and causes the binary to return to its original state. Thus, the binary completes a cycle for every two input triggers and is a scale of 2. By a cascade arrangement of binaries, a counter having a scale of any power of 2 can be obtained.

Circuit Analysis

Four binaries are connected in cascade forming a scale-of-16 which is permuted to a scale-of-10 by two resistor-capacitor "feedback" networks (see Figure 3).

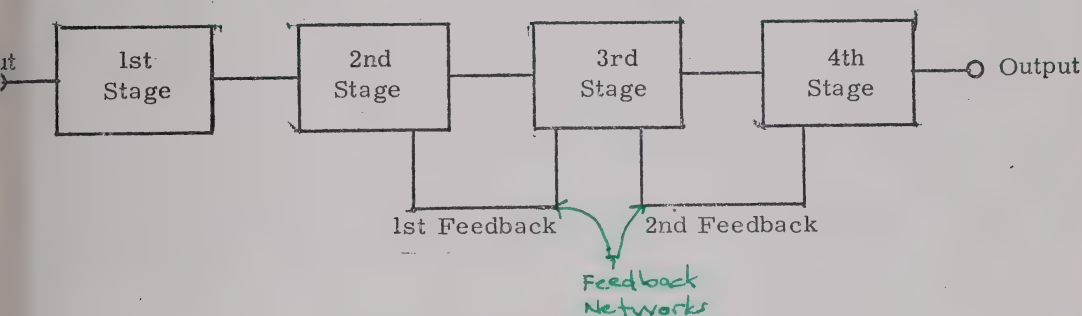


Figure 3, Functional Diagram, Model 705AF

The circuit operates as a conventional binary counter up to the count of four. On the count of four, the third stage is triggered, sending a pulse through the first feedback network, thereby triggering the second stage. Since it requires two inputs to trigger the second stage, this is the equivalent of adding two input pulses and the unit now corresponds to a binary count of six. On the count of six (which is the equivalent of eight in a binary counter) the fourth stage is triggered, sending a pulse through the second "feedback" network and triggering the third stage. This is the same result as if four additional input pulse had been applied and the unit has a binary count of twelve stored in it. The unit again operates as a binary scaler for the remaining four pulses required to reset it to zero. Therefore, by adding the equivalent of six input pulses, the scale-of-16 has been permuted into a scale-of-10.

Section 4

MAINTENANCE

When a Decimal Counting Unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. The counting unit is usually the indicating device of an instrument, and is quite often accused of counting incorrectly when the fault is external to it.

Trouble-Shooting

Two methods are recommended for finding the trouble in a faulty counting unit. First, by observing the lighting sequence while driving the unit at a slow repetition rate, and second, by studying the waveform of each stage while driving the unit at a repetition rate fast enough to be conveniently viewed on an oscilloscope. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. Table 1 lists common troubles. Remember, tubes are the most frequent cause of failure.

Diagrams and Tables

Figure 4 shows the waveforms for each stage. By comparing these with those of a faulty unit, troubles may be isolated.

Schematic drawings will be found at the rear of the manual. The voltages shown were obtained with a vacuum tube voltmeter, a supply voltage of 300 volts, and measured between ground and the point indicated. The unit must be reset to zero to obtain the values shown.

Table 2 lists the voltages and resistances between tube socket connections and ground so that, in conjunction with the schematics and parts location diagrams, all information necessary to maintain the equipment in proper working order is available. It should be remembered that the values given are nominal, and considerable variations may be encountered owing to various line voltage conditions and component tolerances.

Table 1
COMMON TROUBLES*

<u>SYMPTOM</u>	<u>CAUSE</u>
<u>Unit Fails to Count</u>	(a) <u>Insufficient supply voltage.</u> (b) <u>Input signal of insufficient amplitude.</u> (c) <u>Input signal of wrong polarity.</u> (d) <u>First stage inoperative.</u>
Unit Counts Spuriously	(a) Stray output signal. (b) Pulses received through power supply. (c) External voltages picked up by output lead.
Unit Counts Erratically	(a) Input signal too large or small, incorrect rise time. (b) Supply voltage fluctuating too much.
<u>Unit Fails to Reset</u>	(a) <u>Stray counts from reset switch or associated circuitry.</u> (b) <u>Defective component.</u>
Unit Counts in Wrong Sequence (the pattern of lighting is repeated after a definite number of input pulses. One or more lights may be "On" simultaneously during a cycle provided that the number of states per cycle remains constant).	
1. Units skips every other number.	(a) First stage defective. (b) Input circuit supplies double pulses.
2. Two stable stages per cycle.	(a) Second stage defective (count can be 01 or 45). (b) Loss of drive to second stage (01) .
3. Four stable states per cycle.	(a) Third stage defective (count can be 0123 or 6789). (b) Loss of drive to third stage (0123).
4. Six stable states per	(a) Output excessively loaded (count can be 012345-012345). (b) Last stage inoperative (count can be 01234501 etc. or $67_{23}^{89}89$. The count $\overset{8}{2}$ indicates both "8" and "2" lamps are on. (c) Loss of drive to fourth stage (count can be 012345).

5. Eight stable states per cycle or any failure where two successive number are skipped.
 - (a) Second or third stage failure.
6. Ten stable states per cycle, but the lighting sequency is incorrect.
 - (a) Where the "0" neon lamp lights instead of the "4" the trouble is with either the "0" or "4" lamp, and in the majority of cases it is "4". This can happen on any count; zero and four were used as examples. It is also possible that more than one lamp may light in place of, or with the one that fails.
7. Twelve stable states per cycle.
 - (a) When lighting sequence is $0123 \begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 456789-0$, etc. (The count $\begin{smallmatrix} 0 \\ 4 \end{smallmatrix}$ indicates both "0" and "4" lamps are on.)
 - First feedback failure.
 - Second or third stage losing emission.
 - (b) When the lighting sequence is $01234567 \begin{smallmatrix} 23 \\ 89 \end{smallmatrix} 89-0$, etc.
 - Second feedback failure.
 - Third or fourth stage losing emission.

*Reset Unit before troubleshooting.

Table 2
VOLTAGES & RESISTANCES

<u>Tube</u>	<u>Pin No.</u>	<u>D. C. Voltage to Ground</u>	<u>Resistance to Ground (in ohms)</u>
V101	1	170	105K
	2	17	85K
	3, 8	37	12K
	4, 5, 9	Filaments	105K
	6		
	7		
		60	85K
V102	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	93K
	6		
	7		
		55	83K
V103	1	135	100K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	100K
	6		
	7		
		55	83K
V104	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	93K
	6		
	7		
		55	83K

NOTE

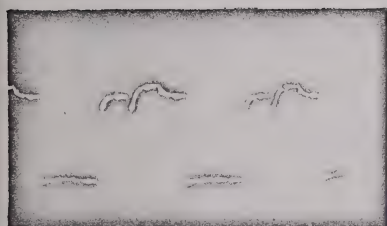
The following waveforms were
photographed from a Tektronix
Model 511D oscilloscope at
f4.5 and 1/2 second.



A. First Stage, Pin 6, V101, UVL + 168,
LVL + 58, frequency 20Kc.



B. Second Stage, Pin 6, V102, UVL + 140,
LVL + 55, frequency 20 Kc.

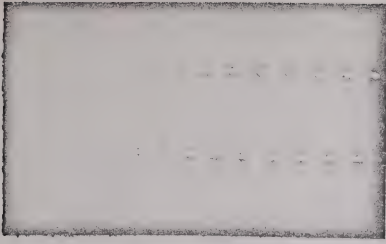


C. Third Stage, Pin 6, V103, UVL + 140,
LVL + 55, frequency 20 Kc.

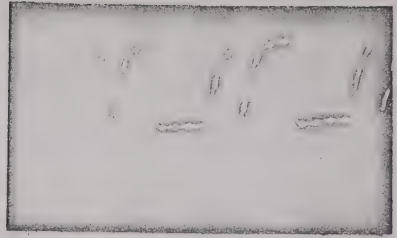


D. Fourth Stage, Pin 6, V104, UVL + 140,
LVL + 55, frequency 20Kc.

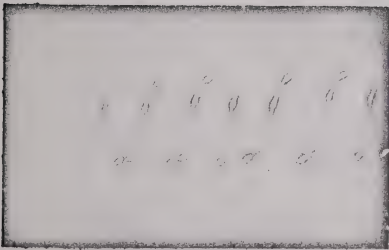
Figure 4 Typical Waveforms



E. First Stage, Pin 6, V101, UVL + 168,
LVL + 58, frequency 100Kc.



F. Second Stage, Pin 6, V102, UVL 140,
LVL + 55, frequency 100Kc.

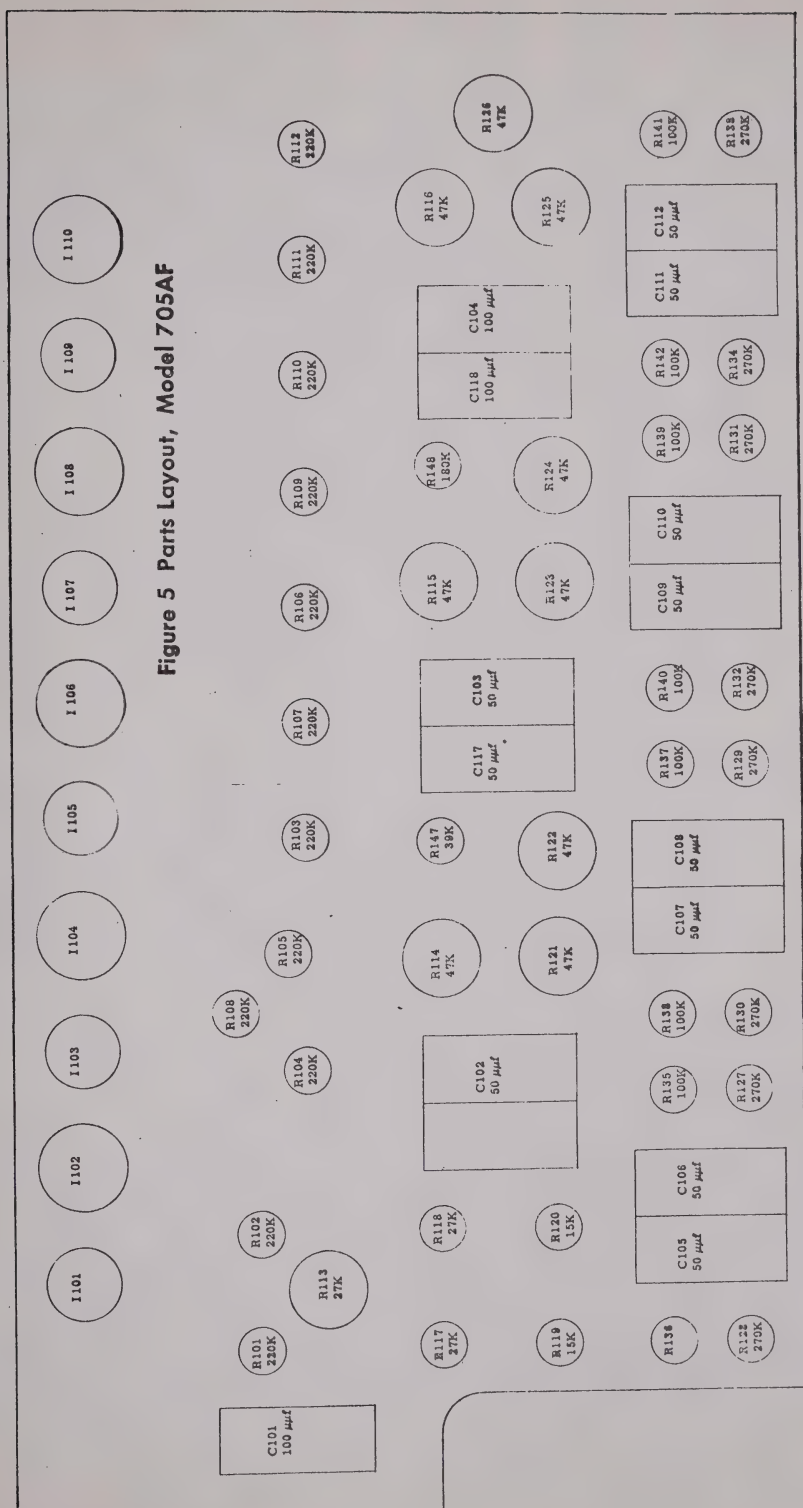


G. Third Stage, Pin 6, V103, UVL + 140,
LVL + 55, frequency 100Kc.

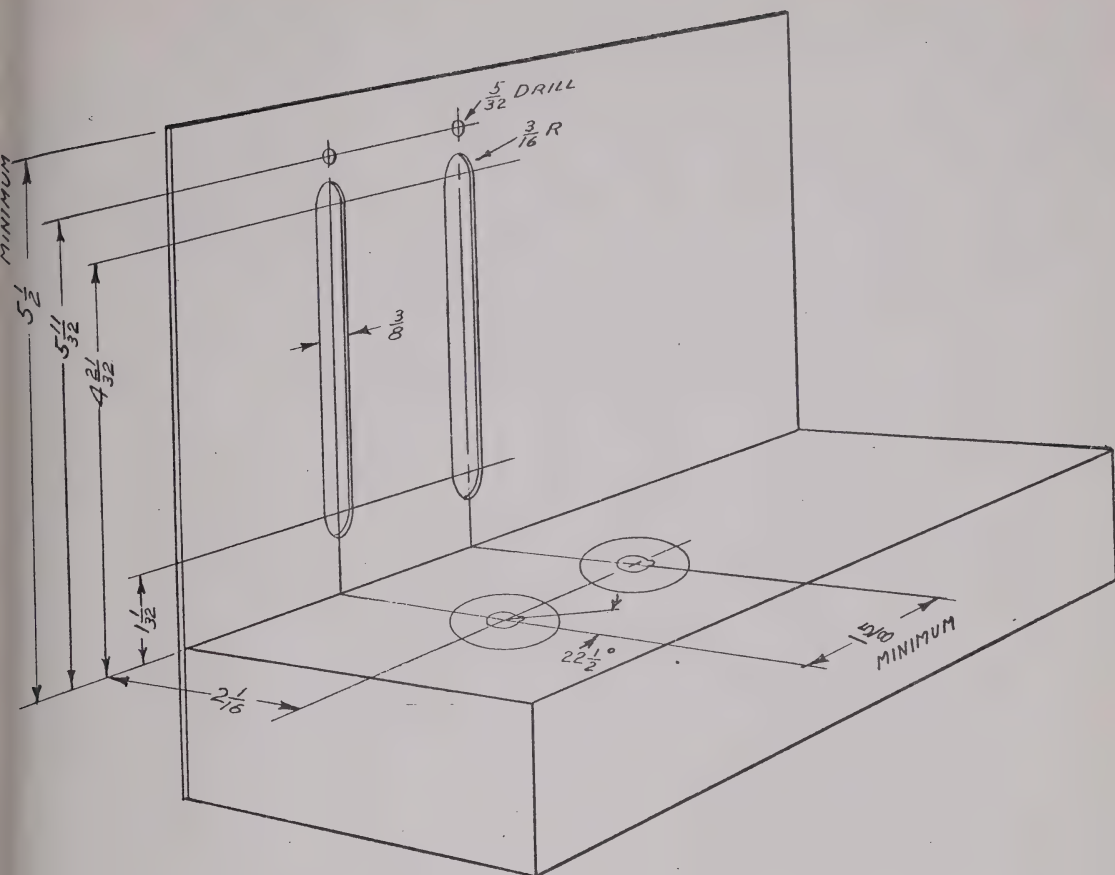


H. Fourth Stage, Pin 6, V104, UVL + 140,
LVL + 55, frequency 100 Kc.

Figure 5 Parts Layout, Model 705AF







NOTE: Dimensions are based on the use of an Amphenol "MIP" 8 or 11-pin socket and .064 metal in the chassis.

Mounting Dimensions, Model 705AF

INSTRUCTION MANUAL

Model 705AH
DECIMAL COUNTING UNIT

BERKELEY division of
Beckman Instruments, Inc.

Richmond 4, California
1 April 1955

The Model 705AH is a Model 705AF DCU modified to reset to zero when it receives a negative pulse at pin 8 of the DCU plug. The schematic diagram of the 705AH appears on the next page. The circuitry is identical to that of the 705AF except:

1. All ground connections to the DCU chassis are removed. The unit operates on a +190 volt and a -110 volt B supply.
2. R135, R137, R139 and R141, are connected to pin 8 of the DCU plug. The negative reset pulse reaches the left grid of each binary through these resistors.
3. All cathode resistors and by-pass capacitors and all resistors formerly connected to the reset line are connected to the negative supply at pin 3 of the DCU plug.

INSTRUCTION MANUAL

Model 705AJ
DECIMAL COUNTING UNIT

BERKELEY division of
Beckman Instruments, Inc.

Richmond 4, California
1 April 1955

The Model 705AJ is a 705AF DCU modified so that it can be reset to 9 as well as zero and will count without indicating. The schematic diagram of the 705AJ appears on the next page. The circuitry is identical to that of the 705AF except:

1. The readout connections to pins 2, 6, 9 and 10 of the DCU plug have been removed.
2. All ground connections to the DCU chassis have been removed. The unit operates on a +190 volt and a $\sqrt{110}$ volt B supply.
3. All cathode resistors and by-pass capacitors are connected to the negative supply at pin 2 of the DCU plug.
4. R135, R137, R139 and R141 are connected to pin 8 of the DCU plug. A negative reset pulse is coupled to the left grid of each binary through these resistors to reset the DCU to zero.
5. R136, R138, R140 and R142 are connected to pin 3 of the DCU plug. A negative reset pulse is coupled to the right grid of each binary through these resistors to reset the DCU to 9.
6. Two selenium diodes (CR101 and CR102) have been connected from one side of the indicating neon bulbs to pin 10 of the DCU plug. When this pin is grounded the voltages developed across the bulbs as the units count are not sufficient to cause them to glow. The unit counts but does not indicate.

Model 707AF
Decimal Counting Unit

Section 1

INTRODUCTION

The Model 707AF Decimal Counting Unit is direct-reading, plug-in electronic counter. The number of counts received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. The maximum repetition rate of the input is one million counts per second. For random pulses the resolution is 0.8 microseconds.

The Model 707AF will drive Models 705A and 705AF which counts at 100,000 cycles per second. Models 705A and 705AF will drive Models 700A and 700AF which count at 40,000 counts per second. These units may be cascaded to form a counter whose total capacity depends only on the number of DCU's used. Thus, six units will count to 999,999, resetting to 000,000 on the 1,000,000th pulse.

Specifications

Count Indication	Direct reading decimal presentation
Power Requirements	Heater: 6.3V at 5.4A near ground potential Plates: 175 to 260 volts (nominal 225 at 60 ma)
Input Requirements Recommended	Negative pulse 150 volt peak amplitude
Rise Time	Less than 0.15 μ sec.
Duration	0.4 μ sec.
Output Characteristics	Designed to drive a 705A or 705AF.
Resolution of Paried Pulses	0.8 μ seconds
Reset to Zero	Instantaneous through opening of grid return
Maximum Counting Rate	1,000,000 cps
Construction	Plug-in unit, 11-pin socket
Dimensions	3" x 5-5/8" x 5-3/8"
Weight	1-1/2 pounds
Tubes	Six 6AL5's and four 5687's

Section 2 OPERATION

Installation

Normally, Decimal Counting Units are installed in Berkeley instruments. No special instructions are necessary. For unusual installations, we invite your inquiry.

The reset pin (pin #3 on the 11-pin plug) should be connected to ground through a normally-closed switch or relay contacts. To reset the unit open the contacts momentarily. Care must be taken to avoid coupling voltage surges into the input or power supply circuits.

Operation

Plate	175 to 260 volts (nominal 225 at 60ma)
Filament	6.3 volts at 5.4 amps near ground potential

Input requirements:

For optimum operation, drive the unit from a pentode, such as a 6AS6 or 6AU6, whose plate is directly connected to the input of the unit, thereby using the first stage of the DCU as the pentode plate load. A negative transient of 150 volts peak amplitude negative with respect to B+ is required to trigger the unit. The rise time should be less than 0.15 microseconds, and the duration at least 0.4 microseconds. When the unit is powered by an unregulated supply, the drive amplitude should be proportional to the supply. If condenser coupling is used to the input diode, the cathodes should be connected through a resistor to B+.

Output requirements:

The output is a rectangular waveform as shown in Figure 4G. It is represented at the output terminal as a change in direct current voltage level. Between counts of "0" to "4" it is 90 volts; "4" to "6", 150 volts, and "6" to "9" 180 volts. The load imposed on a unit must not be more than 100,000 ohms to ground, or a 5,000 ohm resistor with a 100 μ f capacitor to ground.

Regardless of the number of units, all may be set back to zero by momentarily opening the ground connection to a common line connected to pin 3 of the 11-pin socket. Care must be taken to avoid coupling voltage surges into the input or power supply circuits, otherwise they may not remain at zero upon reconnecting to ground. If a pulse is used to reset the unit, it should be 50 volts positive and at least 5 microseconds in duration.

Section 3 THEORY OF OPERATION

The basic circuit of the Model 707AF is a modification of the Eccles-Jordan Trigger Circuit having two stable states, known as a binary.

The type of binary used is shown in Figure 2. It is a two-stage amplifier with the output of the second stage connected to the input of the first. With no input, the loop gain is less than one, and the circuit is in one of its two stable states, i.e., either V1 conducting and V2 cut-off, or V1 cut-off and V2 conducting. The circuit is triggered from one state to the other by making the loop gain greater than one.

The binary is coupled to a single trigger source through the coupling diodes V3 and V4. If the input signal voltage has a steady value equal to $B+$, either diode is conducting, since the potential of the plates of the diodes is either less than or equal to that of their cathodes. Assume that V2 is conducting and V1 is cut-off. If a negative pulse is applied to the input, V3 will conduct. Since its resistance is small compared to that of R1, the plate of V1 is driven negative. This drives the grid of V2 negative through the crossover network R6, R7, C2 and the grid-to-ground capacity of V2.

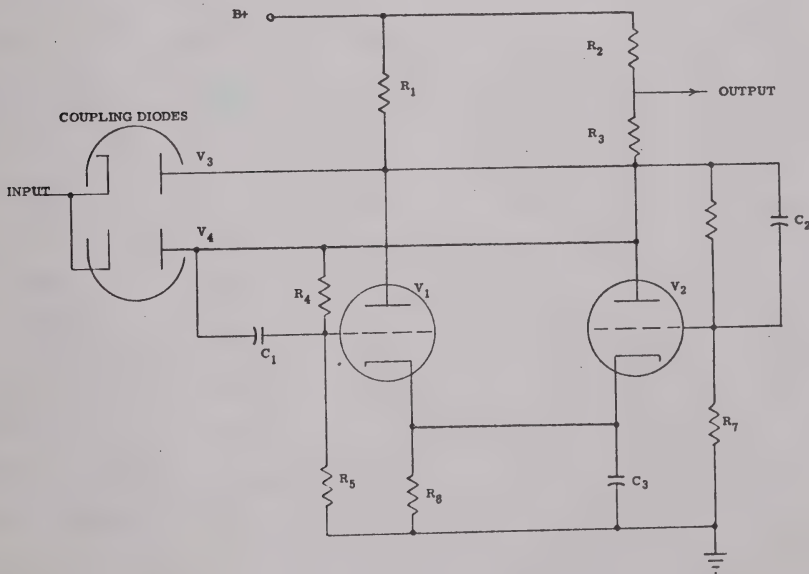


Figure 2 Basic Circuits

When the input pulse amplitude is sufficient, the loop gain of the binary becomes greater than one and it is triggered to its other stable state, i.e., V1 conducting and V2 cut-off. The next input causes the binary to return to its original state. It is seen that the binary is made to cycle once for two input triggers and is a scale-of-2. A counter having a scale of any power of two can be obtained by connecting binaries in cascade.

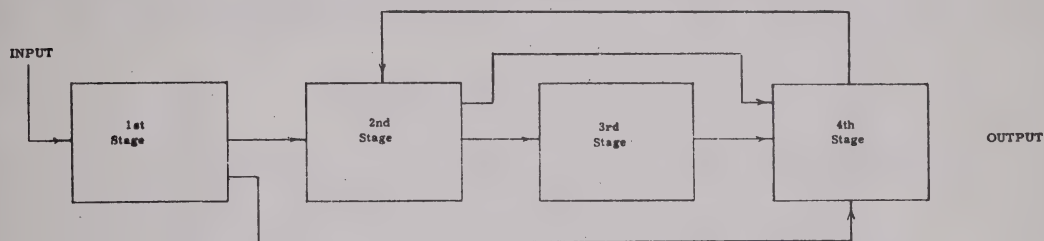


Figure 3 Functional Diagram 707AF

In the Model 707AF, four binaries are connected in cascade, making a scale-of-16, which is permuted to a scale-of-10 by three diodes (see Figure 3). Two of these diodes are used as clamps and the third for coupling. The coupling diode is used to drive the fourth stage in one direction from the first stage. The diode clamps hold the off stage of a given binary to a voltage low enough that it cannot be driven by the preceding stage. In the reset position, one diode clamp holds the fourth stage so that it cannot be driven by the coupling diode from the first stage. On the count of 2, the second stage is driven by the first stage, releasing the clamp on the fourth stage, and the second stage is then clamped by another diode from the fourth stage, so that it cannot be driven by the first stage. On the count of 4, the first stage drives the fourth stage releasing the clamp on the second stage. The state of the four binaries at this point is the same as the count of 10 in a scale-of-16. The clamping and driving the fourth stage from the first has the effect of adding six additional counts on the fourth input pulse. The scaler counts as a conventional binary counter for the remaining six input pulses. The adding of six counts on the fourth input pulse converts the scale-of-16 to a scale-of-10. Decimal indication is obtained by connecting ten neon lamps to the unit through a resistor matrix (see Figure 6).

Section 4 MAINTENANCE

When a Decimal Counting Unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Since the counting unit is usually the indicating device of a larger instrument, faulty operation is often ascribed to it when the symptoms of external faults are displayed.

Troubleshooting

Two methods are recommended for finding the trouble in a faulty counting unit. First, by observing the lighting sequence while driving the unit at a slow repetition rate, and second, by studying the waveform of each stage while driving the unit at a repetition rate fast enough to be conveniently viewed on an oscilloscope. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. Table 1 lists common troubles. Faulty tubes cause most failures.

Diagrams and Tables

Typical waveforms are shown in Figure 4. By comparing these with the waveforms from a defective unit, the faulty stage can be quickly detected. Table 2 lists the voltages and resistances between tube socket connections and ground so that, in conjunction with the schematics and parts location diagrams, all information necessary to maintain the equipment in proper working order is available. It should be remembered that the values given are nominal, and considerable variations may be encountered owing to various line voltage conditions and component tolerances.

Circuit drawings and parts location diagrams will be found at the rear of the manual. The voltages shown were obtained with a vacuum tube voltmeter, a supply voltage of 225 volts, and measured between ground and the point indicated. The unit must be reset to zero to obtain the values shown.

Table 1
COMMON TROUBLES*

<u>Symptom</u>	<u>Cause</u>
<u>Unit fails to count</u>	(a) <u>Insufficient supply voltage</u> (b) Input signal of insufficient amplitude (c) Input signal of wrong polarity (d) First stage inoperative (V107)
Unit counts spuriously	(a) Stray input signal (b) Pulses received through power supply (c) External voltages picked up by output lead
Unit counts erratically	(a) Input signal too large or small, incorrect rise time (b) Supply voltage fluctuating too much
<u>Unit fails to reset</u>	(a) <u>Stray counts from reset switch or associated circuitry</u> (b) <u>Defective component</u>
Unit counts in wrong sequence (the pattern of lighting is repeated after a definite number of input pulses. One or more lights may be "On" simultaneously during a cycle provided that the number of states per cycle remains constant).	
1. Unit skips every other number	(a) First stage defective (V107) (b) Input circuit supplies double pulses
2. Two stable states per cycle	(a) Count is 45-45 (resets to 2). The first cycle after reset is 2345 and the remaining ones are 45). V108 defective. (b) Count is 01-01 (resets to 0). V108 or V103 defective. (c) Count is 23-23 (resets to 0). The first cycle after reset is 0123 and the remaining ones are 23). V110 or V105 defective (d) Count is 45-45 (resets to 0). The first cycle after reset is 012345 and the remaining ones are 45. V103 defective

*Reset unit before troubleshooting

3. Four stable states per cycle.
 - (a) Count is 6789 (resets to 6). V109 defective
 - (b) Count is $\begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 45 - \begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 45$ (resets to $\begin{smallmatrix} 0 \\ 4 \end{smallmatrix}$). V109 defective.
 - (c) Count is $\begin{smallmatrix} 0 \\ 4 \end{smallmatrix} 145 - \begin{smallmatrix} 0 \\ 4 \end{smallmatrix} 145$ (resets to 0).
The first cycle after reset is 012345 and the remaining ones are $\begin{smallmatrix} 0 \\ 4 \end{smallmatrix} 145$). V104 defective.
 - (d) Count is 6789 (resets to 0). The first cycle after reset is 0123456789 and the remaining ones are 6789). V104 defective.
4. Eight stable states per cycle, that is, the pattern of lighting is repeated for every eight input pulses. It is possible to have more than one lamp ON for one or more of these states if there are eight distinct states per cycle.
 - (a) Count is $\begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 456789 - \begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 456789$ (resets to "0" but "4" on while reset switch is open. V110 defective.
 - (b) Count is 01456789-01456789 (reset to "0"). V105 defective.
 - (c) Count is 01236789-01236789 (reset to "0"). V106 defective.
 - (d) Count is $\begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 456789$ (reset to "0"). The first cycle after reset is 0123456789 and the remaining ones are $\begin{smallmatrix} 01 \\ 45 \end{smallmatrix} 456789$. V106 defective.
5. More than ten stable states per cycle as observed on an oscilloscope.
 - (a) Input pulse amplitude too small.
 - (b) Marginal tube in any stage.
6. Unit scales correctly as observed on an Oscilloscope, but lighting pattern is 13579 at high frequency and at a slow repetition rate. (No light on reset).
 - (a) V101 defective.
7. Unit scales correctly as observed on an oscilloscope but lighting pattern is 02468 at high frequency and at a slow repetition rate (resets at 0).
 - (a) V101 defective.

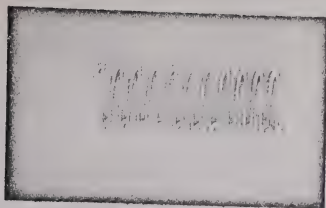
Table 2
MODEL 707AF - VOLTAGES & RESISTANCES

<u>Tube</u>	<u>Pin No.</u>	<u>D. C. Voltage to Ground</u>	<u>Resistance to Ground (in ohms)*</u>
V107	1	200	14K
	2	33	12K
	3, 6	60	3.3K
	4, 5, 8	Filaments	
	7	60	12K
	9	110	14K
	1	138	20K
	2	20	18K
	3, 6	37	3.6K
	4, 5, 8	Filaments	
V109	7	38	18K
	9	68	21K
	1	150	21K
	2	15	18K
	3, 6	36	3.9K
	4, 5, 8	Filaments	
	7	37	21K
	9	55	21K
	1	140	22K
	2	15	18K
V110	3, 6	35	3.9K
	4, 5, 8	Filaments	
	7	35	18K
	9	55	22K

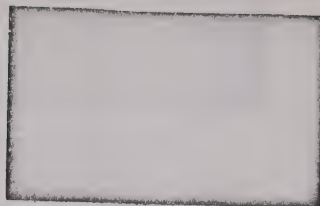
*Note: B+225V
Pins 3 & 8 tied together

NOTE

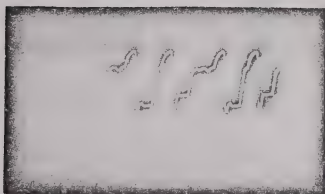
The following waveforms were photographed with a 4 x 5 Grover View camera at f4.5 and one-half second, with a Model 511AD Tektronix Oscilloscope.



A. First stage, Pin 9, V107, UVL + 205, LVL + 110, frequency 500Kc.



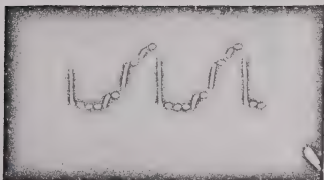
B. Same waveform blanked.



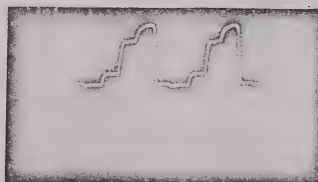
C. Second stage, Pin 9, V108, UVL + 180, LVL + 65, step at + 145, frequency 500Kc.



D. Same waveform blanked.



E. Third stage, Pin 9, V109, UVL + 180, LVL + 65, step at + 145, frequency 500Kc.



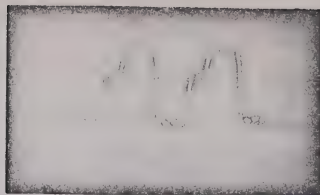
F. Same waveform blanked.

Note: UVL = upper voltage level
LVL = lower voltage level

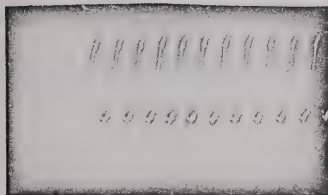
Figure 4 Typical Waveshapes



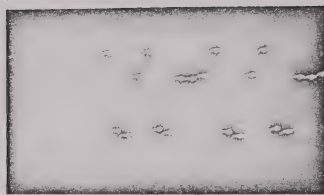
G. Fourth stage, Pin 9, V110, UVL + 180, LVL + 65, step at + 145, frequency 500Kc.



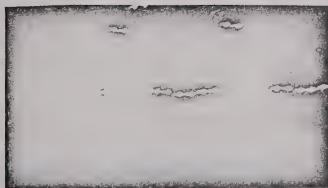
H. Same waveform blanked.



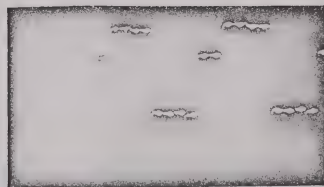
I. First stage, Pin 9, V107, UVL + 205, LVL + 110, frequency 100Kc, (blanked).



J. Second stage, Pin 9, V108, UVL + 180, LVL + 65, step at + 145, frequency 100Kc (blanked).



K. Third stage, Pin 9, V109, UVL + 180, UVL + 65, step at + 145, frequency 100Kc, (blanked)



L. Fourth stage, Pin 9, V110, UVL + 180, UVL + 65, step at + 145, frequency 100 Kc., (blanked).

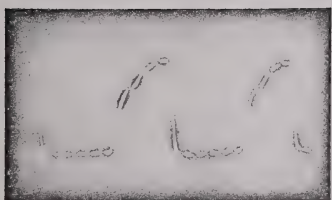
Model 707AF Decimal Counting Unit



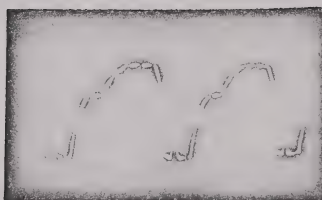
M. First stage, Pin 9, V107, UVL + 190, LVL + 105, frequency 1 Mc. (blanked).



N. Second stage, Pin 9, V108, UVL + 180, LVL + 65, step at + 145, frequency 1 Mc. (blanked).



O. Third stage, Pin 9, V109, UVL + 180, LVL + 65, step at + 145, frequency 1 Mc. (blanked).



P. Fourth stage, Pin 9, V110, UVL + 180, LVL + 65, step at + 145, frequency 1 Mc. (blanked).

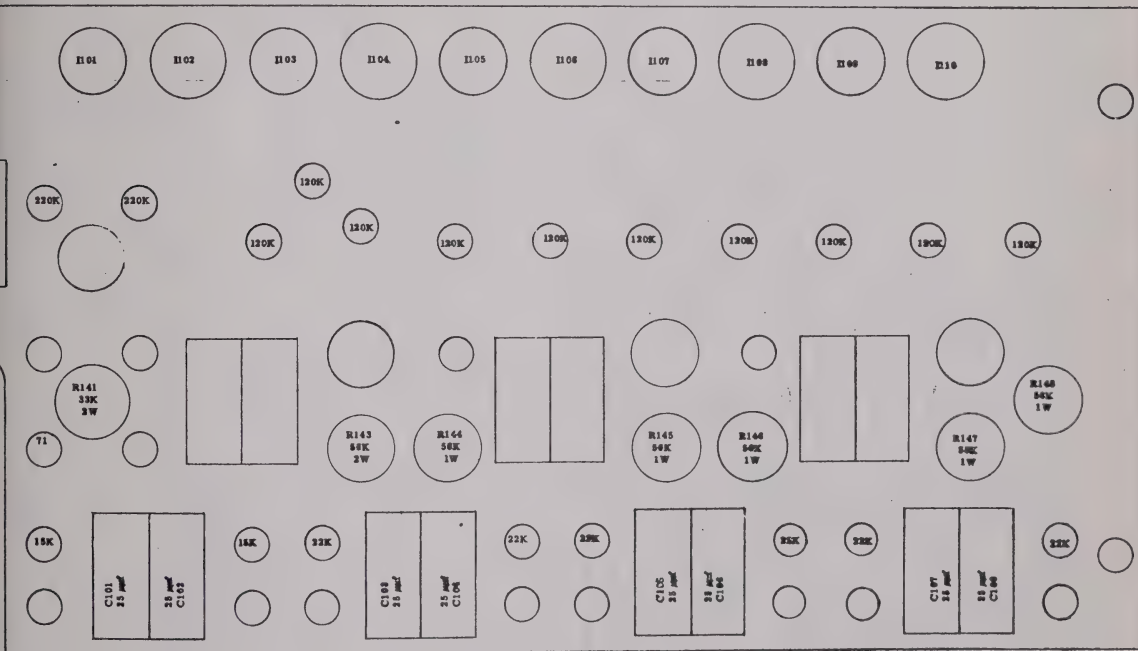
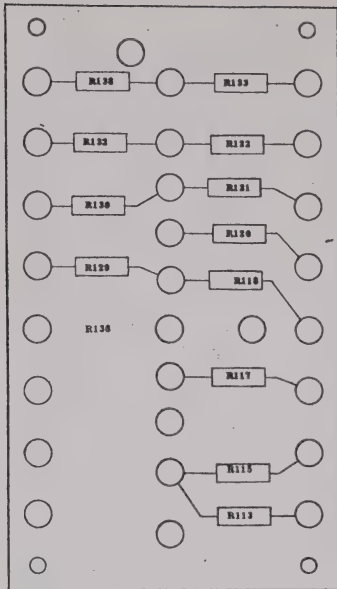
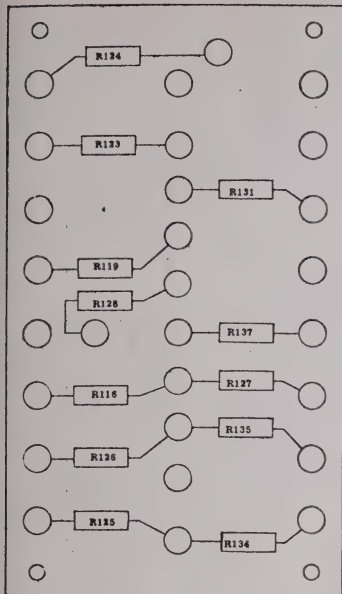


FIGURE 5 PARTS LAYOUT, MODEL 707AF.



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INSTRUCTION MANUAL
Model 707AH
DECIMAL COUNTING UNIT

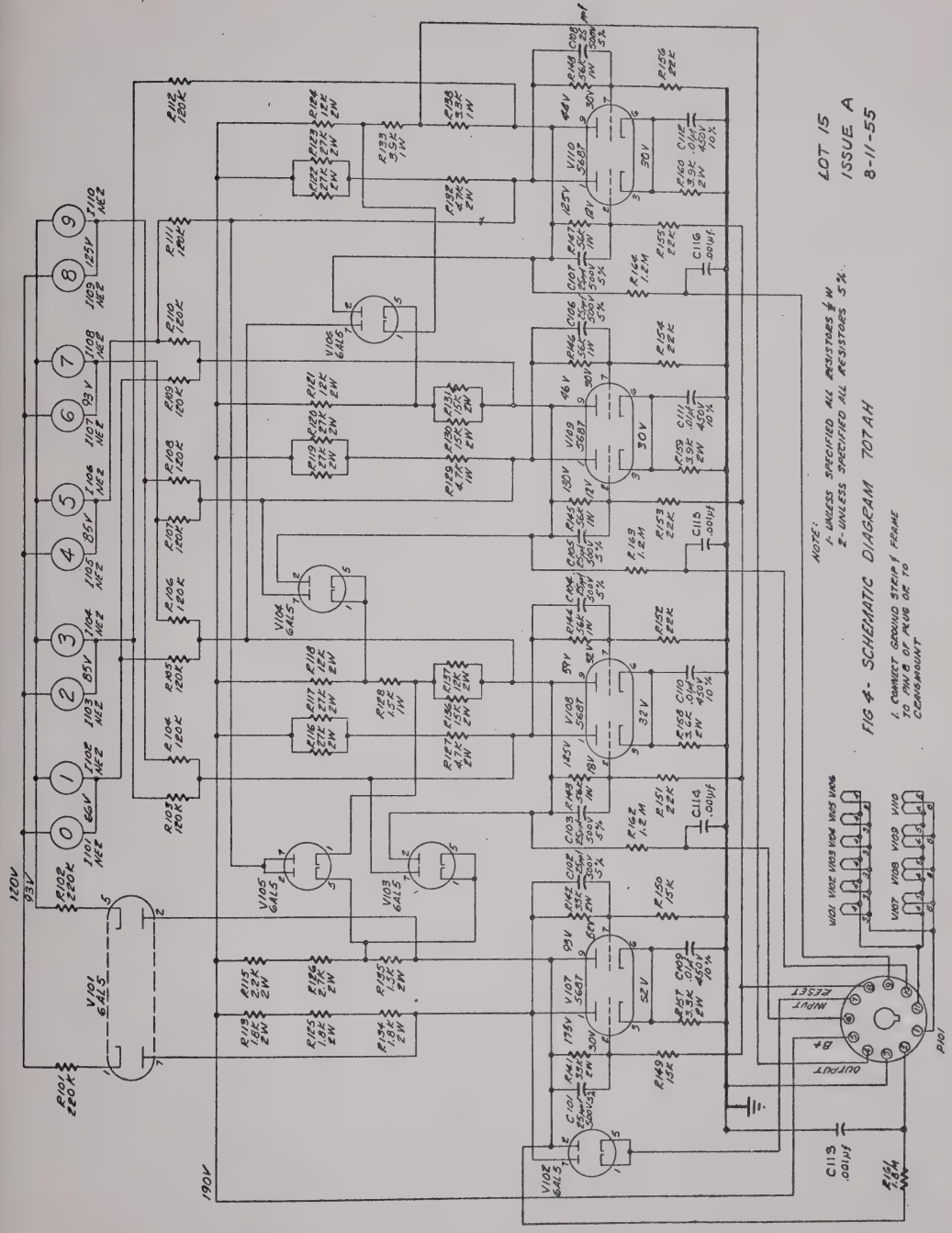
BERKELEY division of
Beckman Instruments, Inc.

Richmond 4, California
1 April 1955

1

The Model 707AH is a Model 707AF DCU modified to reset to zero when it receives a negative pulse at pin 8 of the DCU plug. The schematic diagram of the 707AH appears on the next page. The circuitry is identical to that of the 707AF except:

1. R149, R151, R153 and R155 are connected to pin 8 of the DCU plug. The negative reset pulse reaches the left grid of each binary through these resistors.
2. Pin 3 of the DCU plug and all resistors formerly connected to the reset line are grounded.



LOT 15
ISSUE A
8-11-55

NOTE:
1- UNLESS SPECIFIED ALL RESISTORS $\frac{1}{2}$ W
2- UNLESS SPECIFIED ALL RESISTORS 5%

FIG 4- SCHEMATIC DIAGRAM 707AH

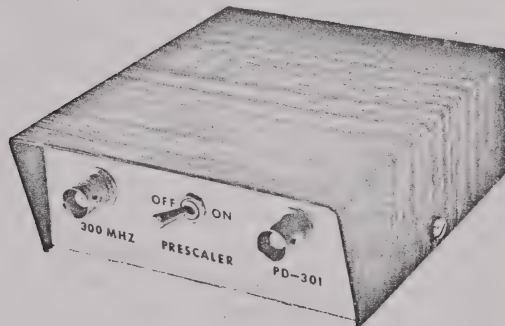
1- GROUNDING STRIP / FRAME
TO PIN 6 OF V106 OR TO
COMMON

Section III

PRESALER---P.D.---301 &

Modifications:

K-ENTERPRISES



PD 301 With Power Supply \$55.50

PD 301 Without Power Supply \$50.50

Include \$1.50 to cover postage and insurance.

K-ENTERPRISES

1401 North Tucker

Shawnee, Oklahoma 74801

PRESALER---P.D.---301 &

Modifications:

K-ENTERPRISES PRESCALER MODEL PD 301

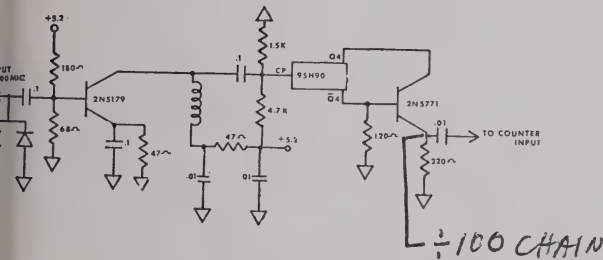
Model PD 301 is a 300 Mhz. prescaler designed to extend the range of your counter 10 times. This prescaler has a built-in preamp with a sensitivity of better than 50 mv at 150 Mhz, 100 mv at 260 Mhz, and 175 mv at 300 Mhz. The 95H90 scaler is rated at typical 320 Mhz. To insure enough drive for all counters, a post amp. was built-in.

The prescaler has a self contained power supply regulated at plus-minus .08%. The PD 301 is supplied without power supply if desired (input 50 Ohms) (output Hi Z). The PD 301 has been tested on the following counters: Heath Kit 1B101 - Heath Scientific 105 - Monsanto 105A - Miida - Regency - Beckman - Hewlett - Packard 524B - and many home builds. In short to this date we do not know of any counter that the PD 301 has failed to work well with. All prescalers are shipped in a 4' x 4' x 1 1/2" cabinet all wired and tested.

PRESALER---P.D.---301 &

Modifications:

PD 301 PRESALER



K-ENTERPRISES

401 North Tucker

Shawnee, Oklahoma 74801

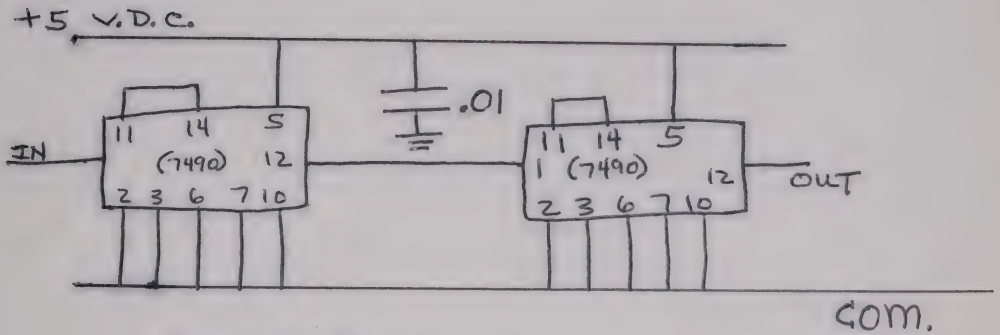
OPERATION:

Connect the output of the PD 301 with a short piece of RG 58U coax cable to the counter to be used. Connect antenna about 20" long (or other suitable pickup) to the input of the PD 301. Start with the antenna loosely coupled, increase coupling until counter begins to count. We have found that the prescaler will pick up a signal from a 1 watt transmitter about ten feet away. Although the front end of the prescaler is protected with limiting diodes care should be taken to prevent overloading. Never hook the prescaler direct to the output of the transmitter.

Using the PD 301 with a receiver you can do a reasonable job of adjusting frequency of a VHF transmitter by scaling down to low band receiver. If you want to zero in on 146.940 just tune your receiver to 14.694 and you're ready to go.

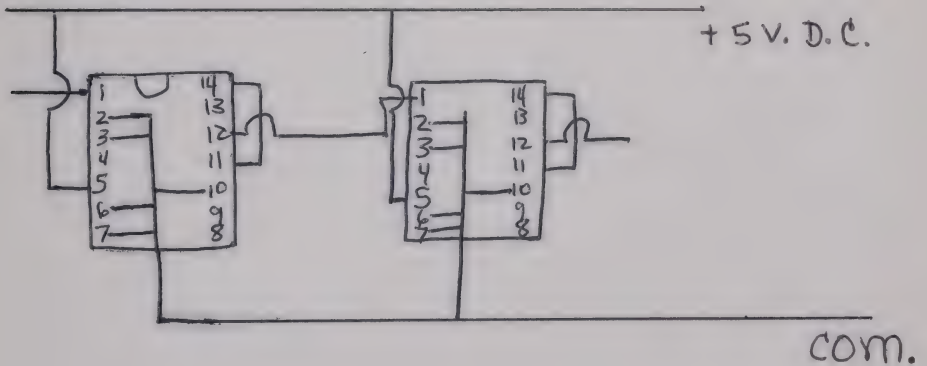
PRESCALER---P.D.---301 &

Modifications:

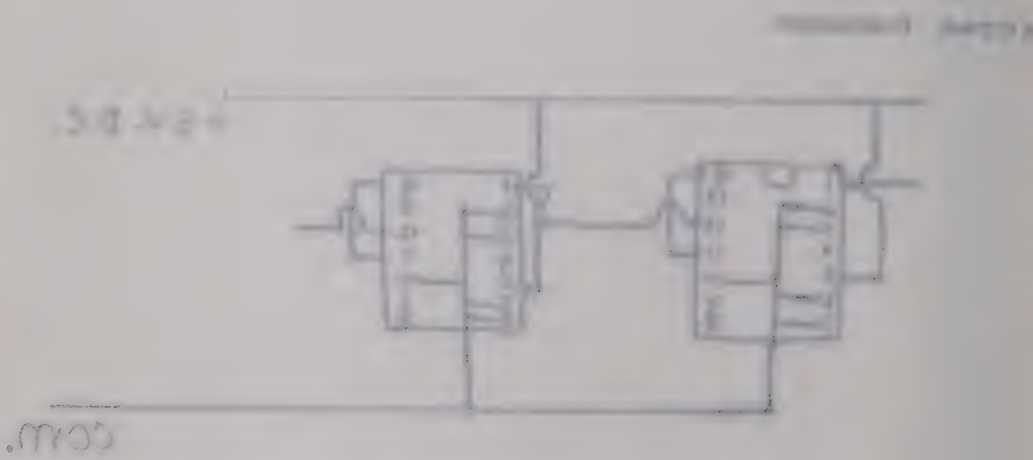
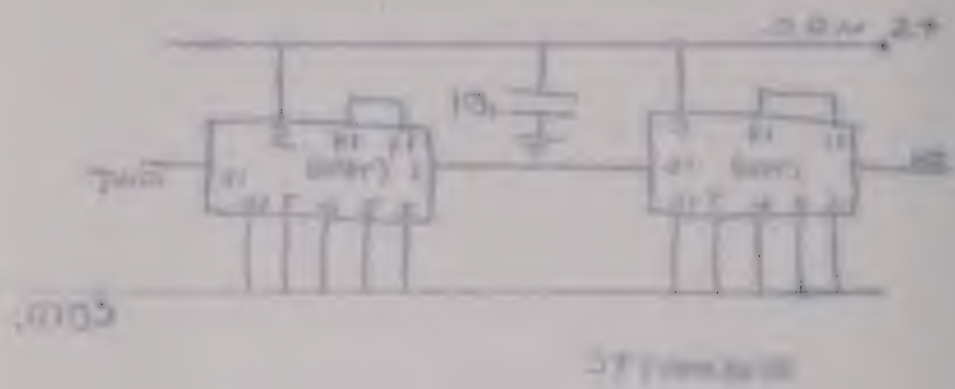


SCHEMATIC

WIRING DIAGRAM



TOP VIEW



The "modifications" section was left out, because only the rack mounting modification was referenced to my 7350.

